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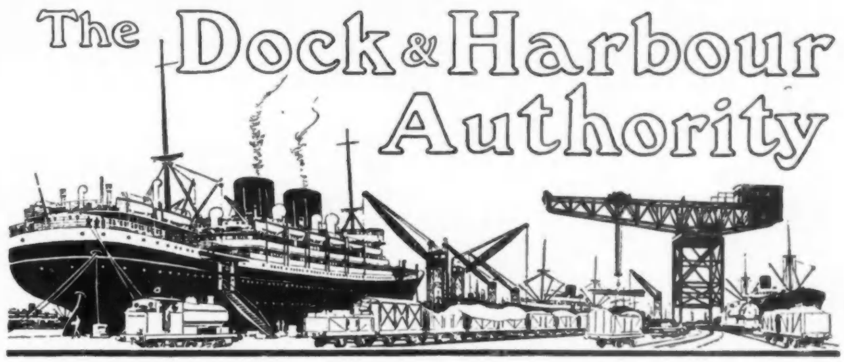

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The Dock & Harbour Authority

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No. 426

Vol. XXXVI.

APRIL, 1956

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Editorial Comments

Apapa Wharf Extension

The opening on the 10th February last, by Her Majesty the Queen, of the new extension to the Apapa Wharf, Lagos, signalises the near completion of one of the largest harbour construction works so far undertaken in West Africa. During the past fifty years Lagos has grown, from a small town situated on an island in a swampy lagoon, to become both Nigeria's Federal Capital and also its largest port. In the past ten years the volume of Nigeria's export trade, consisting chiefly of cocoa, tin, timber, palm oil and ground nuts, has grown steadily. A more significant fact, however, is that the volume of her imports, mainly consumer goods, has in the same period more than doubled. The implied improvement in the standard of living in Nigeria speaks for itself, and is an adequate retort, if such were needed, to the Russian contention that colonial possessions exist to be plundered. Along with the above-mentioned increase in both imports and exports, there has been a growing state of congestion in the Port of Lagos, for which the new Apapa extension, providing five new berths and warehouse space in proportion, will provide the remedy.

In addition to the wharf construction itself, there has been a major reclamation of land, involving the depositing of 2,500,000 tons of sand. Dredging of material from the foundations of the quay wall and its approaches amounted to 875,000 tons; a total of 400,000 tons of quarried stone was used and 13,000 feet of piles were cast and driven. Details of the new works form the subject of the leading article on a following page

This very notable increase in Nigeria's port potential must be seen against the administrative background which has been built up in recent years by the formation of the Nigerian Ports Authority. The Authority was formally constituted on September 23, 1954, and on April 1st, 1955, it took over all railway personnel concerned with port operation and assumed entire responsibility, with some small exceptions, for the operation of the ports. By the establishment of this Authority, the Nigerian Government has wisely placed its port operations on a federal basis, while at the same time absorbing into one management the duties formerly carried out by harbour, lighthouse, pilotage and harbour customs authorities in Nigeria and the Cameroons.

The constitution provides for representation on the Authority of members from each of the federal regions of the country as now constituted, an important provision having regard to the diversity of ethnic and economic aspirations of the three provinces. At the same time, provision is made for representation by port users in proportion to their expenditure in the ports. A further step lies in the direction of creating a stabilised labour force in the ports, engaged and trained by the Ports Authority, which will replace the hitherto casually engaged labour with which the ports were worked.

Provision is also made for the establishment, should it be found on examination to be necessary, of an Inland Waterways Division to exploit and manage the very considerable potential of river-borne traffic. The question of how far the Inland Waterways can be developed has been referred to engineering consultants from the Netherlands, and it is envisaged that the Ports Authority may in due course take over wharf responsibilities in the river and delta ports.

It will be seen, therefore, that the Apapa extension is an adjunct to the existing integration with considerable future possibilities which will go far to assure the prosperity of Nigerian trade.

Mechanical Handling Exhibition.

It has been estimated that more than 250 exhibitors will be taking part in the Mechanical Handling Exhibition to be held at Earls Court, London, from May 9th—19th next. It is claimed by the Promoters that this year's Exhibition will be the greatest display of labour-aiding equipment the world has ever seen and Great Britain, which already exports £100,000,000 of mechanical equipment annually, will be making every endeavour to obtain further orders from abroad.

Visitors to the Exhibition will be interested to note how the need for quicker turn-round on railways and at ports has led to many improvements in the capacity and efficiency of loading and unloading equipment. Also, although the principle of unit-load palletisation is now firmly established, there are signs of a tendency to save both money and space by devising means of assembling and handling palletless unit-loads under appropriate conditions.

In conjunction with the exhibition, an international convention on the subject of mechanical handling will be held. At the Convention, which is the first of its kind, speakers from all over the world will read papers on the latest handling equipment and its application to various industries. A full programme of industrial films, including one recently produced by the Mechanical Handling Engineers' Association, has also been arranged.

As a heavy importer of goods, with a fully employed population, Britain must use her shipping space, factories, warehouses and raw materials to the utmost advantage, and for this efficient handling and storage arrangements are of urgent importance. The stimulating effect of this urgency will be reflected at the 1956 exhibition.

350th Anniversary for Dover Harbour Board.

This year the Dover Harbour Board celebrates the three hundred and fiftieth anniversary of the granting of their charter, for it was on the 6th October, 1606, that James I executed the instrument whereby the control of the harbour was transferred from the Dover Corporation to the Lord Warden of the Cinque Ports and his eleven Assistants. This corporate body was responsible for the administration and maintenance of the port until 1861 when by act of Parliament, a radical change in control saw the Warden and Assistants give place to a representative body under the chairmanship of the Lord Warden of the Cinque Ports. This final form has been retained until the present day, except that since 1906 the Dover Harbour Board has elected its own chairman.

Owing to the proximity to the continent, Dover has since earliest recorded times been prominent in the cross channel trade, although it was not until the coming of the railways that the traffic began to assume significant proportions. Now, at the height of the season as many as thirty-four vessels arrive and depart in one day. Dover

Editorial Comments—continued

handles in a year more than twice the number of passengers handled at any other port in the United Kingdom and, as the largest deepwater harbour between London and Southampton, it is a convenient place of call for ocean going liners.

Although primarily considered as a cross channel port, Dover has a considerable and growing trade in general cargo, both coastwise and foreign. This trade, which has been the subject of post war development by the Board, has resulted from a careful replanning of the dockside areas and the installation of modern cargo handling equipment. Future developments, which are at present under consideration, indicate the Board's confidence in the future prosperity of the Port.

International Congress of Port and Waterway Delegates.

Preparations are being made for holding in London next year, from July 8 to 16, the 19th Congress of the Permanent International Association of Navigation Congresses, members of which comprise governments, corporations and private individuals throughout the world. Similar congresses "for the exchange of information about the construction, equipment and operation of ports and waterways" have been held periodically in member countries since 1885. So far, however, there have been only two in the United Kingdom—the first in Manchester in 1890 and the second in London in 1923.

The congress next year is therefore an event of outstanding importance. It will be held under the patronage of the Duke of Edinburgh and the President will be Viscount Waverley, chairman of the Port of London Authority. Many hundreds of delegates from some fifty countries, including engineers responsible for world-famous canal and port developments, shipowners, and port and inland waterway operators will attend.

The programme, which will include visits to ports and inland waterways and to places of historic interest in all parts of Britain, will be devoted mainly to international discussion on matters concerned with port and inland waterway engineering and operation. Among the questions under discussion will be measures for improving the handling of general cargo between ship and quay or inland transport, berthage for the large new vessels of the tanker fleet, and methods of preventing or reducing pollution of harbour waters by oil. The Congress will thus afford an exceptional opportunity for all persons concerned with consulting and constructional engineering, shipping, port and inland waterway administration, cargo handling and with the supply of port equipment to discuss matters of common interest. After the meetings, the Proceedings of the Congress will be published. These constitute an invaluable record of international thought and progress which is indispensable for all who wish to retain their share in supplying the needs of world waterborne commerce.

To produce a programme worthy of the occasion a strong British Organising Committee has been formed under the Chairmanship of Sir Arthur Whitaker, Consulting Engineer, Vice-President if the Institution of Civil Engineers and formerly Civil Engineer-in-Chief of the Admiralty. The Committee includes representatives of the Ministry of Transport and Civil Aviation, the Dock and Harbour Authorities' Association, the Chamber of Shipping of the United Kingdom, the Institution of Civil Engineers, the Association of Consulting Engineers and the British Transport Commission. Also taking part in the preparatory work are representatives of public works and dredging contractors and the petroleum industry.

To help defray expenses and ensure that the Congress comes up to the high standard set by previous Congresses, the British Organising Committee is issuing an appeal for support in the form of either contributions or guarantees. The Congress is already assured of the support of the Ministry of Transport, and of professional and shipping organisations, and there have already been many offers of hospitality; even so, the greater part of the expenses involved in organising the Congress will have to be met by private subscription.

Topical Notes

Deepening of Gothenburg Channel.

In view of the increasing draught of the large modern tankers, plans for improving the entrance channel to the Port of Gothenburg at a cost of 8,500,000k. have been approved by the Gothenburg Harbour Board, which intends to put the work in hand as soon as the City Council has given its consent. The proposal is to deepen the entrance channel from 10 metres to 12.3 metres (over 40-ft.) and the work is expected to take two years.

The project will be carried out in two parts. The inner part of the channel, eastwards from Knippelholmen, will be deepened to 12.3 metres, and as far as the outer part of the channel, west of Knippelholmen, is concerned, the Harbour Board had two alternatives—deepening the present channel or providing a new one to the north of it. This could be done more cheaply because less work with explosives would be needed. From the navigation point of view either channel would be equally suitable. A further advantage is that a substantial part of the channel would be duplicated, so that outward-bound vessels could use the north channel, and inward-bound vessels the south channel. Ships drawing more than 10 metres, however, would have to use the new north channel.

The Harbour Board has also adopted an extensive investment programme covering the ten years 1956-1965. This will include the provision of a tug harbour, new administration buildings, warehouses, a new quay at the Free Port in No. 11 basin, and extensions to the Gullbergs Quay.

Increased Shipping at U.K. Ports.

Shipping movement in the ports of the United Kingdom during 1955 is analysed in the current issue of the "Board of Trade Journal." The total net tonnage of ships entering with cargo has increased steadily since the war, and since 1953 has exceeded the 1938 tonnage. Despite the dock strike (May 23 to July 2) this increase continued into 1955 and entrances with cargo were 10 per cent. higher than in 1954 and 16 per cent. greater than in 1938. Clearances with cargo have, however, not yet reached the 1938 level; there was a decline of 2 per cent. in 1955 compared with 1954, and 15 per cent. compared with 1938. About 82 per cent. of vessels entering the country in 1955 carried cargo in varying degree, compared with 74 per cent. in 1938.

On the other hand, the proportion of vessels with cargo clearing the country was only 52 per cent. in 1955, compared with 56 and 64 per cent. respectively, in 1954 and 1938. This downward trend in clearances with cargo is mainly accounted for by the fall in exports of coal.

The net tonnage of vessels entering in ballast in 1955 was slightly lower than in 1954, but 37 per cent. higher than in 1948. For several years the net tonnage of entrances in ballast have remained fairly steady, but clearances in ballast have increased, and in 1955 were 18 per cent. greater than in 1954 and 64 per cent. greater than in 1948.

Four ports were affected by the dock strike in 1955, London, Liverpool, Hull and Manchester; Liverpool and Southampton were also affected by the passenger liner strike. Of these ports, only Liverpool and Hull showed decreases in the net tonnage of arrivals and departures with cargo in 1955 compared with the previous year. London recorded the greatest increase in both directions of about 10 per cent.

The net tonnage of coasting trade arrivals with cargo has barely risen over the past few years, and in 1955 it declined by 2 per cent. compared with 1954.

Bluff Harbour Development.

It has recently been announced that Bluff Harbour Board has accepted a tender of £3,221,438 from a French group of engineers for constructing the first stage of a new port development scheme. The complete scheme was originally estimated to cost about £5,000,000, and envisages the construction of an island in an area westward of the present wharves, connected to the shore by road and rail bridges and affording accommodation for eight ships. The island is to cover an area of some 100 acres and there will be a complete railway layout, including marshalling yards and service to each berth. There is also a plan for a foreshore reclamation of 48 acres with a slipway for small vessels.

The Port of Lagos, Nigeria

Description of Apapa Wharf Extension

(Specially Contributed)

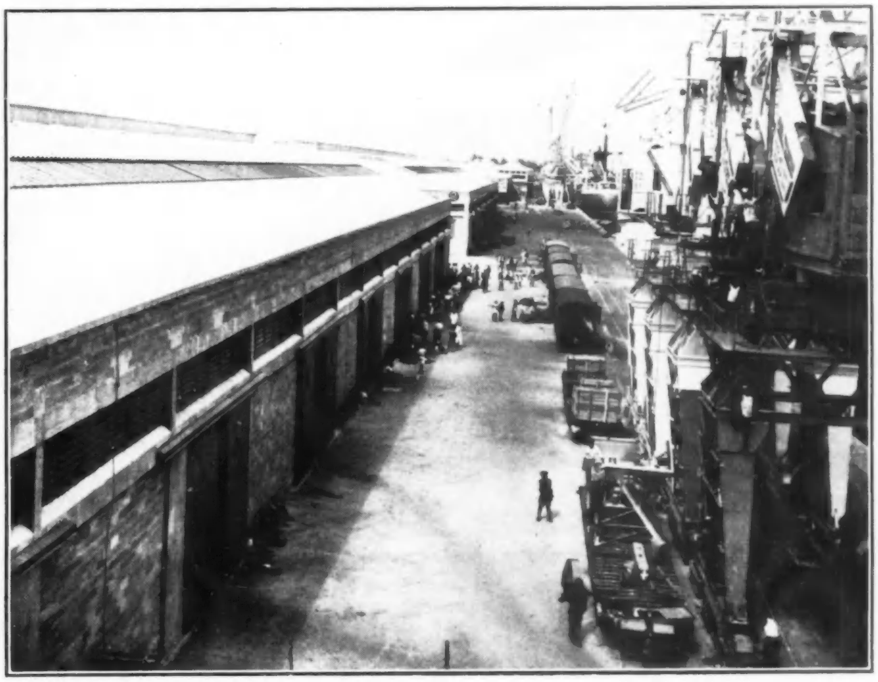
Introduction

Lagos, besides being the Federal Capital of Nigeria, is also the largest port in the Colony. The town and part of the port are situated on an island in an extensive lagoon. The terrain on either side is low lying and swampy for some 500 miles, and Lagos forms the sole outlet for some miles in either direction The entrance was originally encumbered by sandbanks and shifting channels and until 1907 was impassable to ships except those of the lightest draught. Passengers and cargo were transhipped into shallow draught boats, either in the open roadstead beyond the bar or in smooth water at Forcados, 120 miles distant.

Since Lagos was the railhead of a potentially rich area, the advantages of developing a deep water port were obvious, and in 1907 active measures were started under the guidance of the Consulting Engineers to the Nigerian Government. An intensive programme of dredging and construction of moles on either side of the entrance was pursued, with the result that the maximum recommended draught for vessels crossing Lagos Bar was increased from 10 feet in 1907 to 26 feet by 1936.

The port installations of Lagos are divided between the two sides of the lagoon (*See Fig.* 1) On the north side, that is bordering on the town of Lagos itself, are the Customs Wharf completed in 1910, with a length of 1,183 feet, the Elder Dempster terminal at Wilmot Point and the coal wharf on Iddo Island. The principal installations are, however, to be found on the left bank at Apapa, which has the advantage of being situated on the mainland, and is the railhead of the Nigerian Railway system. At Apapa are located the Marine Department Dockyard, floating docks, bulk oil installations and the Apapa Deep Water Wharf, which was completed in 1927. Initially the wharf was 1,800 feet long, constructed of concrete, with a depth alongside of 32 feet. Four berths were provided equipped with four double-storey concrete sheds, each 340 feet long and 70 feet wide, with a storage capacity of 14,000 tons. Full rail facilities and cranage were installed.

While the export and import needs of the Colony have been adequately met up to the time of the Second World War by the installations briefly described above, it became apparent in 1947 that with the anticipated increase of exports and consequent increase of imports of consumer goods, the existing wharves would be severely overtaxed, and there would be serious delay both in the unloading of import cargo and the export of Nigerian produce. In addition, the Customs Wharf was showing signs of decay due to corrosion of the cast iron and steel screw piles. It was anticipated that by 1960 the total tonnage of imports and exports to be handled per year through the port would amount to 1,500,000 tons. The then existing deep water berths, together with the private or " sufferance " wharves handling cargo from and to lighters, were at that time dealing with some 900,000 tons, leaving an anticipated surplus of some 600,000 tons to be handled, by 1960, at any new berths. It had been found, from past experience, that approximately 300 tons of cargo could be handled per foot of quay wall per year. On this basis the new wharves would require to be some 2,000 feet in length.



The Apapa Wharf in operation after completion of extension works.

At the end of 1947, the Government of Nigeria instructed their Consulting Engineers, who had been responsible for the design of the entrance moles, the coal wharf, the original Apapa Wharf and the Customs Wharf, to prepare the necessary plans for an extension of some 2,500 feet at the Apapa Wharf. Tenders were invited towards the middle of 1949 and a contract was let in January, 1950.

Wharf Construction

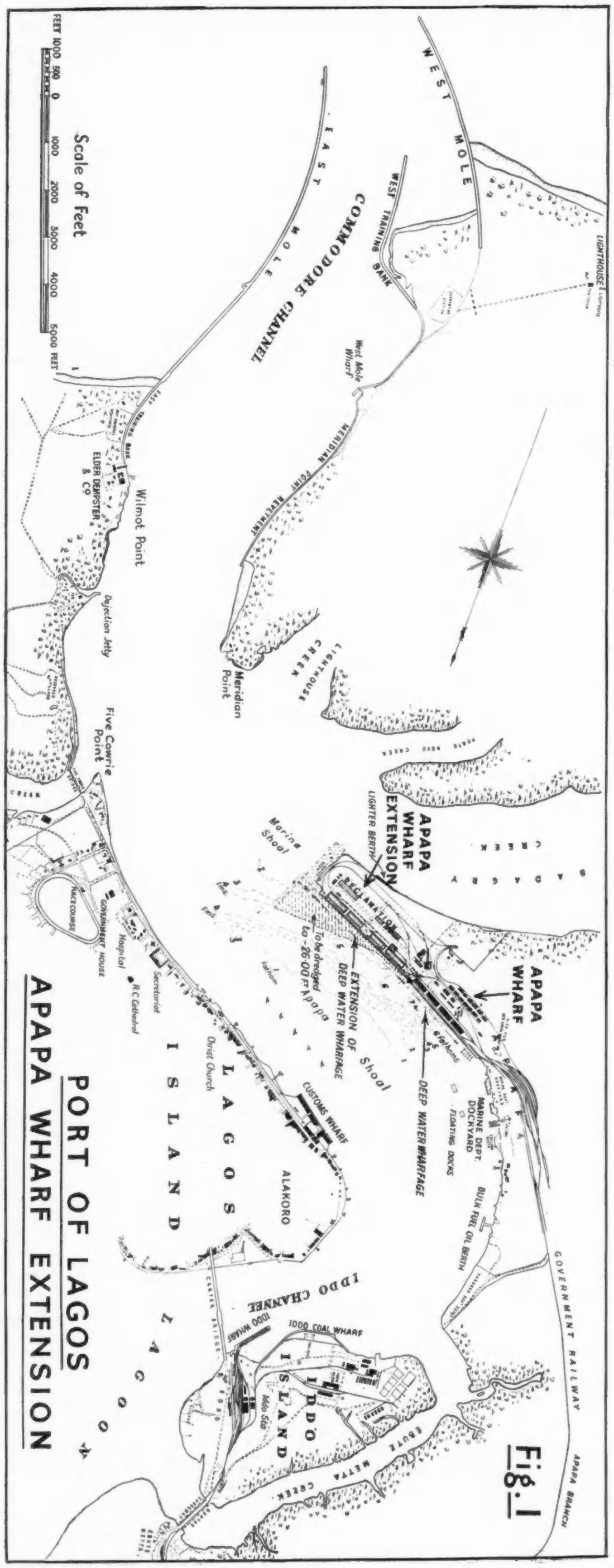
The works, which are one of the largest harbour development schemes to be carried out on the West Coast of Africa since the war, are indicated in Fig 2. The wharf wall is 2,565 feet long and is constructed of 11,568 precast concrete blocks, weighing between 10 and 15 tons each, set in sloping bond. The bulk of the materials used in the Apapa construction were sand and stone. Sand is abundantly available in the Lagos Lagoon, but the nearest source of stone is at Abeokuta, some 65 miles away to the North, but fortunately placed on the railway.

Aro quarry, as it was called, had originally been worked when construction of the moles at the entrance of the harbour was begun in 1908 and again during the building of the Apapa Wharf, but had not been used except on a small scale since then. At the very outset it became necessary to put this quarry into a state to make it possible to supply up to 400 tons of stone per day. This involved the provision of excavators for stripping the overburden, air compressors, drilling equipment, new crushing and screening plant and haulage equipment. In addition to supplying the needs of Apapa Wharf, Aro quarry had to supply the requirements of various Government Departments and to produce all sizes of stone, from 5 ton blocks to 3/8 in. granolithic material.

The height of the quarry face was approximately 70 feet and it had been developed somewhat in the shape of a horseshoe. Tropical heat in such enclosed surroundings made working conditions very trying, not only for the six or seven Europeans in charge, but also for the local people.

To start with, light weight drills were used for the main drilling but later it was decided to use wagon drills on the grounds of economy of operation. Stone at the face was loaded by hand into trays which were emptied into dumpers by crawler cranes for delivery to the crushers and into railway wagons for supply as

Port of Lagos—*continued*



rubble. Earlier in the operations, Decauville equipment had been used for transporting stone to the crushers, but this was abandoned as track maintenance costs were too high.

Three crushing and screening installations were set up, partly to use equipment available and partly to supply a wide variety of sizes at any one time. In the first three years these units were operated by diesel engines, but when electricity supplies became more abundant locally, electric motors were installed, as the maintenance costs of the diesel engines were very high, due to the adverse working conditions.

The quarry had its own marshalling yard and practically all production was despatched by rail. A train left from Apapa to Aro each evening with empty wagons and the full wagons were hauled on the return trip, arriving by 7 a.m. next morning. Thus the contract was supplied with stone on a daily basis.

A typical cross-section of the quay wall is shown in Fig 2. A trench was dredged to a foundation level of 40,50 feet below L.W.O.S.T. and in this trench was deposited a mattress, 5 feet thick, of rubble varying in size from 56 lb. to 10 cwt. This rubble was deposited from bottom-opening barges and skips and was roughly levelled by divers. On the top of this rubble was deposited a mattress of 2 inches gauge crushed granite for a depth of 6 inches, this stone being screeded by the divers using an 80 lb. per yard flat-bottom rail. On the completion of this screeded mat of stone, the concrete blocks were lowered into the water by a diesel-electric crane travelling on the top of the blockwork as it was completed, the blocks being guided into position by divers. In general, the blocks were set in "slices" which had a lean backwards along the line of the wall of $22\frac{1}{2}$° from the vertical. With this type of construction, and due to the loads imposed on the wall by the blocksetting crane, each slice of blocks was able to settle to its maximum extent, independent of adjacent slices. Each block was provided with a groove on the front or forward face and a tongue on the back or rear face, thus interlocking one slice of blocks with the next and preventing lateral movement.

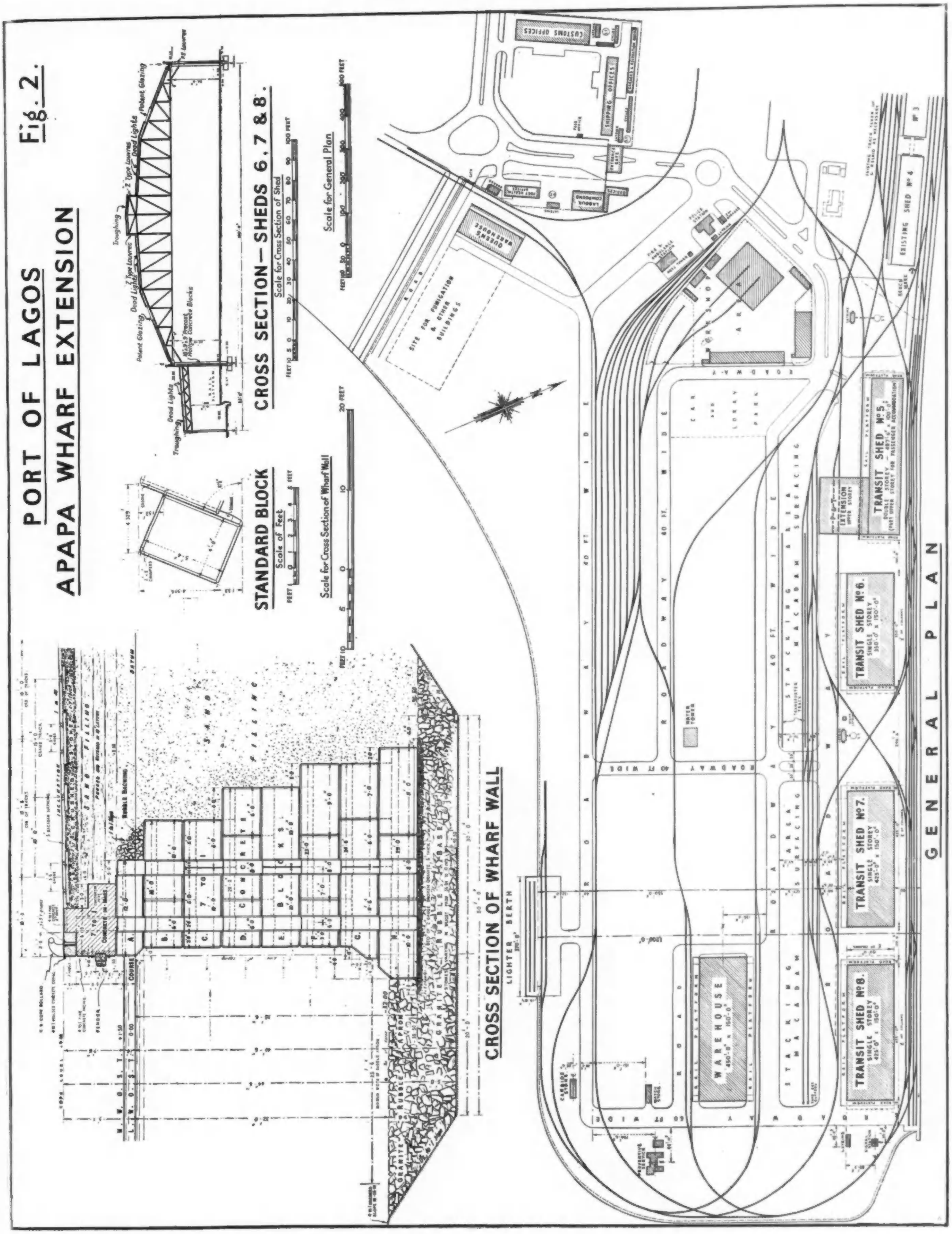
During the course of construction, the wall was built with a batter of 6 inches in its full height, *i.e.*, leaning backwards. When the sand filling was pumped behind the wall, the pressure on the back of the wall caused it to come up into the vertical position. As the construction of the blockwork was completed up to a level of 2.5 feet above L.W.O.S.T., the concrete superstructure up to a level of 9 feet above L.W.O.S.T. was constructed, as shown in the cross-section (Fig. 2). Due to the range of tide in Lagos harbour being comparatively small, only one horizontal timber fender with a rubbing strip was required, and this was fixed to the wall by means of mild steel straps and bolts, enabling the fender to be renewed easily as and when required.

Land Reclamation and Dredging

In order to provide land on which transit sheds, roads, rail tracks, etc., could be constructed, an area of 100 acres was reclaimed behind the quay wall. The southern and eastern extremities of the reclamation area were bounded by a rubble bank, 10 feet wide at the top with a $1\frac{1}{2}$ to 1 outside and 1 to 1 inside slope.The material used for reclamation was sand obtained from the dredging for the foundations of the wall, from the dredging of the approach channel to the wharf extension and from other areas in the harbour. Some 2,285,000 tons of sand were dredged and pumped into the reclamation area.

It had been decided that, instead of using a long floating pipeline, necessitating a booster station, to convey the pumped fill material from the dredger to the reclamation area, it would be more advantageous to dispense with the floating pipeline and to pump-load the material into barges at the suction dredger, thence to be towed

Port of Lagos—continued



Port of Lagos—*continued*

to a semi-stationary reclamation dredger which pumped the material ashore through a short land pipeline to the reclamation area. This method gave complete freedom of movement and it was possible to move the suction dredger from area to area wherever more favourable material could be obtained. The units used for these barges were comparitively small and economical, the suction dredger being equipped with a 12in. pump and the reclamation dredger with a 14in. pump, both driven by diesel engines. A 14in. pipeline was used for distribution. Four 100 cu. yd. barges and two 120 h.p. tugs, together with a small launch for communication, were provided. They proved entirely successful and worked throughout the contract until the main dredging and reclamation works were completed in April, 1955. Other equipment was used in the wall excavation and the Lighter Berth approach which will be described later.

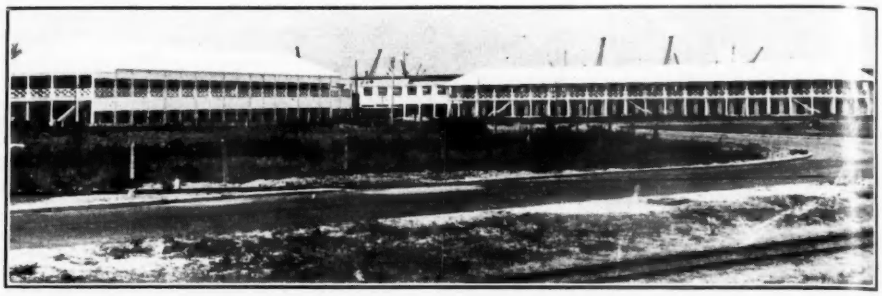
The first operation was to form a spit some distance inside the alignment of the wall and parallel to it. This was to provide a suitable position for mooring the reclamation dredger and also to facilitate setting out the works. It also had the advantage of enabling a start to be made on reclamation works before either the wharf wall or the rubble bank had got under way.

When the wall on one side and the rubble bank on the other had progressed far enough, the areas between them and the spit were filled in. The spit proved so useful that it was maintained ahead of the wall and rubble bank construction until the very end.

Main dredging operations commenced with the excavation of the wharf wall trench and the dredging of the wharf approach area followed. As the total dredging quantity fell short of the reclamation total, borrow areas were operated in the later stages to make good the deficiency.

The personnel of the dredging units were Dutch and great skill was shown in the handling of the distribution mains so that the surface of the reclamation finished accurately to the levels required.

The general layout of the reclamation area and the works constructed thereon are indicated in Figs 1 and 2, and the main features are as follows.

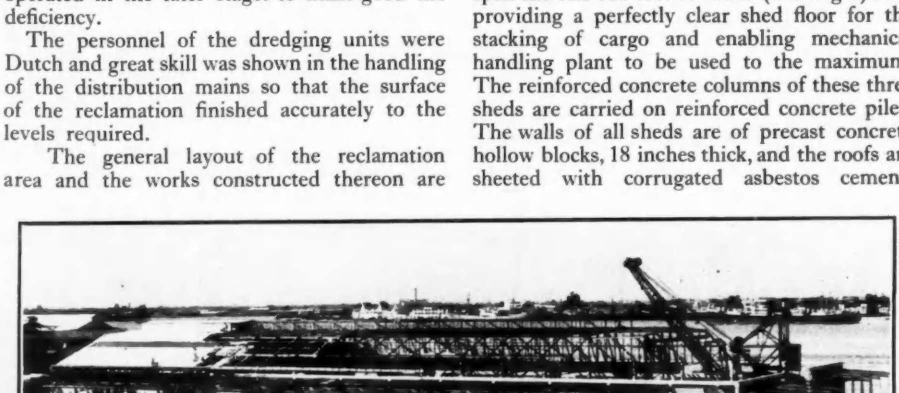


The Custom and Shipping Offices.

The Transit Sheds

Four transit sheds have been provided to cover the five berths. The first shed is a double storey shed 487 ft. 6in. long and 100 ft. wide. The upper floor is laid out for passenger accommodation and for the handling and sorting of mail. The passenger accommodation comprises a waiting hall, with immigration counter, buffet counter, toilets, telephones and the like, together with a large examination hall. On the harbour side is an electric lift for passengers or baggage and a further four electric lifts are installed at the rear of the shed. The ground floor of the shed is for storage of imports and exports, and, in the rear and at the ends of the sheds, road and rail platforms, protected by canopies, are provided. A balcony, 12 feet wide, runs around the shed at upper floor level and an aluminium gangway spanning between the balcony and the ship provides access for passengers.

The other three sheds are single storey sheds. One is 350 feet and two are 425 feet long and all are 150 feet wide. The steel roof trusses span the full 150 feet of width (See Fig 2) thus providing a perfectly clear shed floor for the stacking of cargo and enabling mechanical handling plant to be used to the maximum. The reinforced concrete columns of these three sheds are carried on reinforced concrete piles. The walls of all sheds are of precast concrete hollow blocks, 18 inches thick, and the roofs are sheeted with corrugated asbestos cement. As in the case of the double storey shed, road and rail platforms are also provided. Each shed on both the landward and the harbour side is fitted with large sliding doors in each alternate bay of 25 feet.



Shed No. 6 under construction.

Produce Warehouse

Amongst the other more important structures included in the works is the Produce Warehouse which is 450 feet long and 150 feet wide, with road and rail platforms, on each of the long sides. Construction is similar to that of the transit sheds except that steel columns cased in concrete have been used and there is a centre column every 75 feet down the centre of the shed, with a lattice girder spanning between these columns and carrying the two intermediate trusses. This warehouse has been designed so that conveyor equipment, leading to the wharf where outloaders will be installed, can be added at a later date. In connection with the Produce Warehouse, two fumigation chambers are to be constructed for dealing with infested produce before placing it in store.

Other buildings include a Queen's Warehouse 195 feet long by 80 feet wide, two small buildings for the storage of dangerous cargo, two double storey blocks of offices, one for the Customs Department, 233 feet long by 67 feet wide, and one for the various shipping firms and importers, 229 feet long by 19 feet wide, a Preventive Service Station, Police Station, Fire and Ambulance Station, and various latrine blocks.

Maintenance Facilities

An extensive mechanical workshop area is being constructed for the repair and maintenance of various items of mechanical handling plant which will be brought into use when the wharf extension is completed. In this area (See Fig. 2) will be built a large main workshop with repair bay, a gear store, timber store, paint store, crane and car garages and petrol filling station.

All road traffic for the old and new Apapa Wharf will pass through the new entrance gate which is a reinforced concrete structure allowing four lorries or cars to be inspected by the Police under cover, before entering or leaving the wharf area. Adjacent to this entrance gate is a double storey Port Health Office and a labour call compound for the engagement of dock labour.

Plans are being prepared for the construction of a double storey office block for the use of the Nigerian Port Authority's local staff, and

Port of Lagos—*continued*

Shed No. 5 nearing completion.

this building will be sited just inside the new entrance gate and adjacent to the road roundabout.

Railway Facilities

On the quay in front of the sheds, three lines of railway tracks have been laid flush with the surface. There is a further track behind the transit sheds serving the rear platform. Behind the sheds runs a road, 62 feet 6 inches wide, and on the landward side of this road are three further rail tracks. Adjacent to these tracks are two open stacking areas, 70 feet wide, one of which is spanned by a 5 ton Goliath crane. Beyond the stacking areas are two further roads, each 40 feet wide, with the necessary cross roads allowing a one-way traffic system to be adopted. The total of roads and surfaced areas amounts to 250,000 sq. yds.

In addition to the rail tracks referred to in the previous paragraph, there are cross rail tracks between the end of the old wharf and the start of the new, between the two centre transit sheds and at the downstream end of the last shed, allowing wagons to be removed from the front of any shed without interfering with those at other sheds. The rail tracks are also carried around the down-stream end of the reclamation area to its rear, again allowing a system of one-way traffic. A marshalling siding, consisting of seven tracks, each some 1,000 ft. long, has been provided. The total length of rail tracks laid in the reclamation area amounts to approximately 10 miles.

A ring water main of 6in. diameter cast-iron pipes has been laid around the site with fire hydrants at suitable intervals, and a large elevated water storage tank has also been constructed to provide an adequate storage of water. A booster pump is to be installed in the main to produce a higher pressure at the hydrants if and when a fire occurs.

Lighter Berth

In the rear of the reclamation area and alongside the rubble bank, a lighter berth has been constructed. This berth is 370 ft. long and has a deck 30 ft. wide. The depth of water alongside will be 16 ft. below L.W.O.S.T and the deck will be 7 ft. above L.W.O.S.T. The structure consisted of a precast concrete beam and deck construction on reinforced concrete piles up to 58 ft. in length. The piles were driven from a floating piling plant and the precast units were erected by a 7-ton derrick crane.

A large area was dredged to give a depth of water of 16 ft. in the approaches. The large floating grabbing crane, the 400 cu. yd. barge and a 120 h.p. tug were used for this operation.

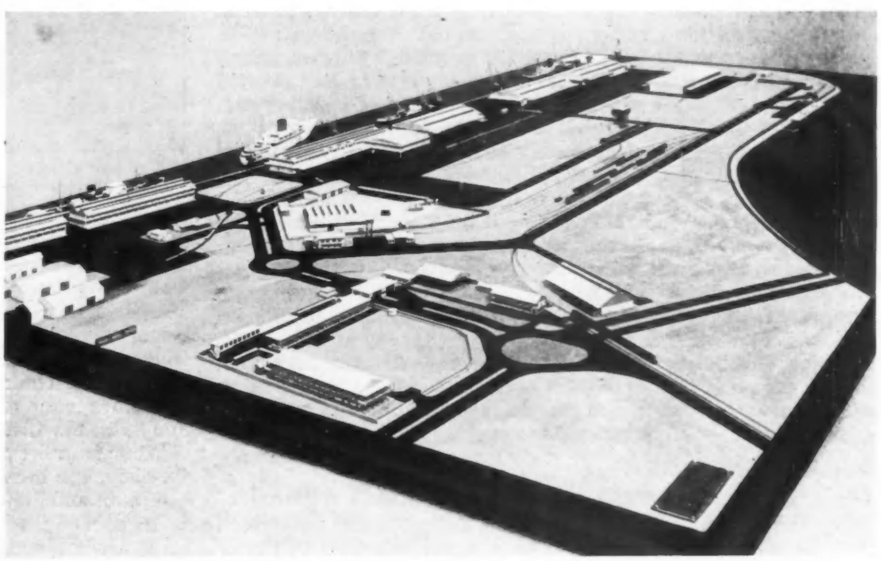
All sheds, warehouses and buildings will be lit with fluorescent lighting and all roads, stacking areas, marshalling sidings and the quay will be lighted by sodium vapour lamps Various substations have been constructed around the site, the main supply coming from the main substation on the old wharf. A control station has been erected near the entrance gate for the control of the police lighting required at night time.

It is anticipated that the whole works will not be completed until the end of 1956. The Nigerian Ports Authority, who have now taken over the operation of the port of Lagos, took over the first two berths and the first two sheds when they were completed on 12th April, 1955. The next two berths and the third shed were handed over on 27th August, 1955, and the last berth and shed on 26th October, 1955.

Estimated Cost of Works

The works are estimated to cost £4,500,000. They were carried out for the Government of the Federation of Nigeria, for whom the Crown Agents for Oversea Governments and Administrations acted as agents. The Consulting Engineers were Messrs. Coode & Partners of London, who obtained the services of Messrs. Preece, Cardew & Rider of London, to assist in the electrical installations. The main contractors were Messrs. Richard Costain Ltd. of London. On works of this magnitude it is natural that a large number of firms supplied materials for the works, but these are so numerous that they cannot all be listed in an article of this nature. Mention should be made, however, of Messrs. Thos. Summerson & Sons, Ltd., who fabricated the railway and crane track material, Messrs, Rashleigh Phipps Ltd., who were sub-contractors for the electrical installation, Messrs. Marryatt & Scott who manufactured and installed the lifts in the double storey shed, Messrs. South Durham Iron & Steel Co., who fabricated the steel for the transit sheds and Messrs. Universal Asbestos Cement Co., Ltd., who supplied the asbestos roof sheets.

A separate contract was placed by the Crown Agents for Oversea Governments and Administrations with Messrs. Stothert & Pitt, Ltd. of Bath, for the supply and erection of the wharfside electric level luffing portal cranes. On the main wharf three 3-ton and nine 5-ton cranes have been supplied and erected, and the contract also included the supply and erection of the Goliath crane for the stacking area. In addition, two 3-ton cranes were supplied for the old wharf to replace two 2-ton cranes



Model of the Apapa Wharf constructed by Hunting Aerosurvey Ltd. and subsequently presented by the Consulting Engineers to the Nigerian Ports Authority.

Port of Lagos—continued

H.M. the Queen and H.R.H. the Duke of Edinburgh inspecting the model of Apapa Wharf during the official opening ceremonies. Between the Queen and the Duke may be seen Mr. C. A. Dove, Chairman of the Ports Authority, and on the left of the Duke is Mr. D. C. Coode of the Consulting Engineers. On the extreme left of the picture is Sir James Robertson the Governor General and on the extreme right, Mr. G. H, Farleigh, the Consultants' resident engineer.

which have been transferred to the Lighter Berth.

Official Opening Ceremonies

The Apapa Wharf Extension was formally opened by Her Majesty Queen Elizabeth II on February 10th, 1956, on which day the facilities were in full use, there being five ships alongside, loading and dis-charging cargo. To commemorate the ceremony Her Majesty unveiled a bronze plaque erected on the rear upper wall of the double-storey transit shed. Before the unveiling of the plaque, members of the Board of the Nigerian Ports Authority, representatives of the Consulting Engineers and the Contractors, together with officers of the Authority, had the honour of being presented to Her Majesty and His Royal Highness, the Duke of Edinburgh. During the course of the proceedings Her Majesty and His Royal Highness inspected a table model of the works as they will be when completed. The model, which was to a scale of 50ft. to 1in. was made by Messrs. Hunting Aerosurveys Ltd., from drawings and photographs supplied by the Consulting Engineers, and was sent out to Lagos at the end of January 1956.

Before their departure, by launch, for the ceremony at the Ijora "B" Power Station at the northern end of the harbour, Her Majesty and His Royal Highness drove round the wharf extension in their car.

Timber Roof for Dock Shed

Design Adopted by Port of Liverpool

The Mersey Docks and Harbour Board has adopted timber trusses, 88-ft. in length and designed by the Timber Development Association, for the roof of a 500 yards long dock shed now being built in Liverpool to replace a shed built in 1880 and destroyed by enemy action in May 1941. This large building, to be erected at an estimated cost of £200,000, forms part of the Board's post-war reconstruction programme.

Plans for new accommodation at Alexandra Dock were drawn up soon after the war when the use of timber was controlled. The initial reconstruction scheme envisaged the use of steel, but in 1953 the removal of softwood licensing made possible the use of timber.

Since 1947 the Timber Development Association has devoted special attention to the use of timber as a structural material, particularly for longspan industrial roofs, and upon learning of the Board's general and structural requirements for the building, the Association submitted a design for 88-ft. span Mansard type trusses, and, in collaboration with the Engineer-in-Chief to the Board, Mr. A. B. Porter, later arranged for full scale trusses to be subjected to strength tests. Upon the successful outcome of these tests, in course of which three trusses were tested, the design was adopted by the Board, and the trusses, ninety-two in number, are now being fabricated in Liverpool from British Columbian Douglas fir.

In view of the critical shortage of berths in the Port of Liverpool, the quay and shed at Alexandra Branch Dock No. 1 will be brought into use in stages, but it is hoped that the building will be in full commission in about nine months time.

Economic and Safety Factors

It is understood that in reaching a final decision in favour of timber the Board took into account its economic claims in both first cost and in maintenance, advances in the technique of timber construction, and the greater safety of a timber structure in the event of fire. Experience gained during war-time fire fighting in dockland showed that the early collapse of metal roof components constitutes a danger of some magnitude. From the point of view of fire fighting timber roofs, despite extensive charring, may still function for longer periods and, if they collapse, do so without pulling the walls down.

Douglas fir of a quality complying with that described in B.S. Code of Practice 112 "Structural Use of Timber in Buildings" has been specified for the trusses, which have been designed to

Strength test on timber trusses for new shed at Alexandra Dock.

carry a flat-pitched roof with an accentuated Mansard tilt at the extremities. On the side facing the quay they will be supported on a series of steel columns and at the rear will rest on a brick wall, the greater part of which survives from the original shed. The trusses, framed with the aid of $2\frac{1}{2}$-in. diameter split-ring connectors are 88-ft. long and will be placed at 15-ft. centres along the length of the building.

The main contractors are J. Gerrard and Sons Ltd., Swinton, Lancs, while the roof trusses are being fabricated by Walter Holme and Son Ltd., Liverpool.

While steel fire doors will be installed between adjoining bays of the shed, 112 heavy timber sliding doors are being made by Wm. Thornton and Sons Ltd., Liverpool, sixteen of them for a series of 20-ft. openings at the back of the building and the remainder to form a continuous movable curtain along the quay. All these doors, the largest of which measures 24-ft. x 15-ft. 4-in., are framed in pitch pine, and in the essentials of their construction conform to the Board's standard practice.

Port Accounting

The Management of Financial Records

By THOS. HAWORTH, C.B.E., F.S.A.A.

(Concluded from page 336)

Having covered the field in which Management Accounting is likely to find its sphere of usefulness, it might be of interest to look at some of the everyday features and problems.

Wages Analysis

Currently, the employment of labour and the use of dock and harbour facilities are likely to be of primary importance. If we are engaged in the handling of cargo, we shall probably be drawing some of our Labour from the pool of the National Dock Labour Board and of course be involved in making returns which will give a weekly picture of state of work, as measured by the volume of earnings. We may be able to contrast earnings with information of the volume of cargo handled, but that is hardly probable simultaneously except in the smaller ports or in ports handling predominently bulk cargoes.

There has been a tendency in the later years for cargo handling to be remunerated by piece work payment. That method has been almost universal practice in London for more than a generation, but there were many other ports where a straight day work payment had been the rule.

Payment by results may appear to be the obvious method of rewarding labour, but the " results " cannot always be measured, and most arrangements are and have to be subject to a flexibility in application to allow for abnormal or exceptional conditions of working. The administration of such a method is costly and multiplicity of rates in dock working still leaves a lot of room for disagreement, with stoppages of work on what often appears to be little or no provocation.

It is rather remarkable that whereas in the dock industry there has been a drive to establish piecework payment, in other industries or in other large industrial undertakings, there has been a movement in the reverse direction. And that is perhaps more noticeable in the U.S.A. than in Britain, though here the Amalgamated Engineering Union, which has probably more experience than any other similar body, is now publicly stating that day work has many advantages.

The policy of industrial relations which determines piecework payment may be a matter of psychology rather than arithmetic or mathematics, but the Accountant ought to be able to produce evidence of what is happening.

In dock working, most jobs are undertaken by a " gang " of men, the number varying according to the job, or the custom of the port, and prices are negotiated and settled on the assumption that they will allow a man or gang to earn say 30 per cent. above the day work rate without undue exertion. Usually there is a trial period, after which the rate will be confirmed or adjusted on the results shown by the trial.

Since this involves setting a unit value for each job by reference to a common standard, we might assume that, by and large, the same piecework rate represents the same amount of effort, regardless of the character of the commodity or the precise operation to which it is subjected. And if the men of a gang each earn £1 11s. 2d.—to the nearest penny—when the day rate is 24s. per 8-hour day, the condition of a 30 per cent. better pay has been satisfied.

Unfortunately things are not so simple as that, because not all time is being paid at piecework. For some jobs there is no rate; and there are many abnormalities to be taken into consideration. There can be stoppages for rain; the gangs can be on hand before the ship is ready; there can be bad stowage of cargo; or the cargo itself may be dirty or in a bad condition. For these and many other similar reasons, allowances have to be made, usually in the form of adjustments of working time, so that for example, there might be allowances of two hours each man for the day's interruptions, which would increase the earnings of the example given above to £1 17s. 2d. and increase the precentage rates from 30 per cent. to 55 per cent. because the measured piecework quantity £1 11s. 2d. has been earned in six hours.

Experience has shown that on the general run of dock work in the handling of cargo in London about two-thirds is paid as piecework and the other third is for unrated work or jobs, and for time allowances to meet abnormal conditions. Surplus earnings over day work rate show wide variation, but taken as a weekly mean, over all piecework operations, and on a fairly large universe of work, they have tended to remain constant, notwithstanding the abjurations for increased output.

Earnings under piecework methods of payment are the aggregate of four components:

(a) Day work rate for hours at work by the piece.
(b) Premiums for overtime, meal time working etc.
(c) Day work rate for hours allowed for difficult working abnormalities.
(d) Surplus earnings derived from the measured output, after deducting the day work payment under component (i) hereof.

and a Digest of the Pay Roll week by week is valuable in this form, particularly as the rates $\frac{d}{a}$ gives the current comparison with the base rates of 30 per cent. or whatever other rates may have been used. Component (iii) is also an item to be watched closely.

There will be other grades of workers, attending or servicing the various units of plant and of course, the maintenance gangs. Most likely they will be paid at day work rates with overtime premiums. Their work will be reported or vouched by the Foreman on a Time Sheet and some form of Pay Roll analysis will be required to review the expenditure and its character. For the Engineering Grades, probably the broad classification of property and plant under the heads of the Plan of Accounts will suffice in the first place, to be tabulated in greater detail at monthly or at quarterly intervals.

The amount of information to be extracted from the detail which has gone to the building up of the Pay Roll will in any event be largely a domestic matter. For the Superintendent or the Departmental Manager, it will obviously be in greater detail than the General Manager will require. Particularly in Dock and Harbour working the Pay Roll is the big element of cost, for here there is no end product and no expenditure on materials other than in the form of working stores and may be repair parts. (See Fig. 3.)

There will be certain sections where the labour force is more or less constant as an authorised complement, and where the pay will differ week by week only to the extent that it includes overtime working. In this group we will probably have the lockmen who may be working shift times or tidal hours. We may also have the men working the quayside cranes, though these men are sometimes regarded as being included in the piecework gangs and sharing in the surplus earnings. Or the quay cranes may be hired to the Shipowner or Stevedore, with or without the crane driver.

Plant User Analysis

The Time Sheets of crane drivers can provide useful information of the use and loading of the quay cranes. In most Dock undertakings, these valuable appliances have a very small load factor and they demand a constant review of their employed time and of the hourly or daily rates of hire. A Dock with a good equipment

Port Accounting—continued

PAYROLL DIGEST (Departments engaged in the handling of Goods) .... Dock, Week ended ....

Particulars	Dept.No.		Dept.No.		Dept.No.		Dept.No.			Dept.No.		DOCK TOTAL	
	THIS week	Moving Average	THIS week	Moving Average	THIS week	Moving Average	THIS week	Mo Ave	ing ge	THIS week	Moving Average	THIS week	Moving Average
	£	£	£	£	£	£	£	£		£	£	£	£
Payroll Earnings:													
Pieceworkers -													
Piecework													
Time Allowances													
Premiums, Cons. & Diffis.													
Dayworkers-(a) P.T.Labour..													
do (b) Other Labour.													
Foremen & Clerical Grades													
TOTAL PAYROLL ...													
	Man/hrs	Man/hrs	Man/hrs	Man/hrs	Man/hrs	Man/hrs	Man/hrs	Man/	hrs	Man/hrs	Man/hrs	Man/hrs	Man/hrs
Man-hours paid:													
At Piecework													
At Daywork - (a) P.T.Labour													
(Including Time Allowances) (b) Other Labour													
Foremen & Clerical Grades													
TOTAL MAN-HOURS PAID													
	Units	Units	Units	Units	Units	Units	Units	Un	ts	Units	Units	Units	Units
Units of Output													
Units of Output per Man-hr paid:													
On Piecework													
Overall													
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s.	d.	s. d.	s. d.	s. d.	s. d.
Payroll Cost per Unit ...													
	Man/hrs	Man/hrs	Man/hrs	Man/hrs	Man/hrs	Man/hrs	Man/hrs	Man	hrs	Man/hrs	Man/hrs	Man/hrs	Man/hrs
Standing by (No work):													
Pool Labour													
Permanent Labour ...													

Observations

Fig. 3. Typical Pay Roll Digest.

of quay cranes is likely to be an attraction to shipping where there is freedom in choice of port, but if the hiring charges are too high, they may have the effect of deciding the owners to use the ships' derricks.

For some purposes it will be found that a "Use Return" is required, particularly when plant is hired out on a "bare" basis. Such a Return can often be incorporated in a Log Sheet, or if not formally laid out for that purpose, such a record would enable the details of use to be extracted.

One important record of this character is likely to be the Log of the Dock tugs. Part of the time will no doubt be employed in towing or in escorting vessels to and from their berths. But there will be times when they are not so employed and it may be that experience, fortified or verified by Log Book records, will suggest that it might be more economical to hire a tug as and when required.

It must be clear from all this, when the use of plant or equipment is to be the subject of a charge, that there must be some record upon which that charge can be formulated.

Sometimes there may be a comprehensive record in the form of a Ship's Day Book, though the name does not matter. It will be a complete record from entry into Dock of all services rendered to the vessel until departure. Such would include the use of Quay Cranes; Cluster or Ships' lighting; supplies of fresh water; charges for Dock dues and for discharging or loading cargo depending on the custom of the Port; Towage and any other of the services usually rendered or of the plant hired to facilitate the stay in Port.

Cargo Records and Statistics

The paragraphs which follow are written with London experience in mind and the methods detailed are not to be taken as a generalisation of conditions at other ports, or as being applicable indiscriminately to any other port. Their purpose is to indicate some of the sorts of problems likely to be employed in Port working at some stage or other and to suggest means which have been tried and may be helpful in reproduction.

Where the Dock undertaking is engaging in the handling of cargo, there will be an important series of records to be kept, and particularly if cargoes are held for warehousing. For Immediate Deliveries, which usually means delivery to be taken from the Quay within 72 hours of landing, nothing more than a chronological record is likely to be necessary, assuming the documents of title to be in order. Such a record could be made as a carbon copy of a Dock Pass, if Security or Police required evidence to allow the transport to leave Dock premises. Another copy could be used as a Delivery Report to the office for raising charges. The point here of course is that there should be the attempt to have the one official record in such a form as will suffice without further copying or separate recording for these other purposes.

If we are engaging in Warehousing operations, we shall require a permanent or a more permanent record than will suffice for Immediate Delivery. Particularly we shall have something in the form of a Stores Ledger, though as a rule more appropriately designated as a "Cargo Ledger." It will be indexed as a series of personal accounts in the name or names of the owners of the different parcels. The quantity held for account of the interested party will be entered from the copy Landing Account or other similar document such as a Weight account or Specification.

Deliveries will be allowed against Delivery Orders and will be appropriately written off the account. With some commodities we may be dealing with Transfer Orders passing the title in the stock or in part of the stock to some other person or interest. That usually means opening another Ledger Account, against which to write off any further deliveries of the parcel transferred, though experience of the trade or of the particular trader sometimes allows the subsequent records to be carried on the original Ledger account.

Actually the whole routine is very much akin to the Stores routine of the Industrial undertaking with the quantity demonination only. Usually and conveniently it will provide room for detailing the charges whether for Landing or Delivery services or for such other services as Sampling, Bulking, Coopering etc. and for writing such charges off the record to show in fact they have been rendered for collection.

Such a Ledger record is often better kept on paper ruled only in feint squares of say $\frac{1}{4}$-in. (because of the variety of Marks and Specification) upon which tabular columns can be ruled, if necessary, rather than to use paper already ruled up, and also a loose leaf record is much to be preferred with proper Audit control of the issue and jerquing of completed accounts.

It must not be overlooked that H.M. Customs may be interested

Port Accounting—*continued*

in the information given in the Cargo Ledger for commodities subject to ad valorem duties and their requirements must obviously be taken into account. This could also apply to commodities subject to specific duties of which Wines and Spirits; Tobacco; Sugar may be instanced.

For general control it will be necessary from time to time, probably month by month, to aggregate the stocks being held. During the war this feature became especially important because Returns had to be rendered to the various Government Controls. The usual method of keeping Control or Total accounts, aggregated from the various documents of movement in or out, became somewhat of a problem. Little difficulty was experienced in keeping such Total accounts up to date for Deliveries, but Cargo inwards was not so simple. The point was how to account for landings in progress before the final Landing or Weight accounts had been compiled. In the course of discharging a cargo, the quantites landed daily are usually approximated for the payment of Piecework earnings and not until the whole parcel has been completed is it possible to have an accurate account of the quantities actually held. As it were, we have stock in two stages; the one as given by the official formal documents and the other a stock in suspense.

One way of dealing with this situation would be to raise Suspense accounts for stock in process of landing and to use the Landing Account or other formal document to transfer from the Suspense Account to the formal Stock Account. Such a method is cumbersome and in the ordinary way, if there are no such obligations to a Control body, it should suffice to disregard landings in progress, notwithstanding that deliveries may actually have been made in the interim. In other words for our accounting we should rely upon the formal authentic record of the verified quantities and not deal with approximations.

The Delivery Reports, while serving the purposes above mentioned are the media by which information of the form of transport can also be collected. Today most deliveries will be made to Road Transport vehicles, but deliveries at rail connected Docks are also made to Rail and again they may be made to water transport in the form of Barge or Coastwise shipping. A " box " at the foot of the Delivery Report indexed for the form of transport can be completed with a tick or a cross so as to facilitate sorting and subsequent tabulation.

A monthly Return summarising these stock movements could usefully give the following information:

(a) Cargo discharged.

(b) Cargo overside.

(c) Cargo landed for Immediate Delivery.

(d) Cargo landed for Warehousing.

(e) Cargo delivered ex Warehouse.
  (i) to Road Transport.
  (ii) to Rail Transport.
  (iii) to Water Transport.

(f) Stock held at close of period.

It could also usefully contain the Shipping data of Arrivals and Departures in terms of N.R.T. possibly classified according to Rating subdivision, as:

(a) Overseas.

(b) Mediterranean.

(c) Baltic.

(d) Near Continental, and

(e) Coastwise and Irish.

Aggregates for the current year to date could parallel the monthly totals except, of course, for the Stock totals. And the corresponding totals for the previous year may be assumed to be detailed also.

The trade of a Port, in terms of total tonnage of goods handled or of its detailed composition, becomes of some importance when cargo is handled overside. London, as is well known, is a port of this character. Apart from vessels which trade direct at riverside wharves and industrial premises, there is what is known as the " Free Water Clause " whereby barges are allowed entry into Dock waters to collect from or to deliver to vessels berthed at the quay, goods for transport to riverside wharves and industrial premises also.

These goods are handled directly by the Shipping Company (or by their Stevedoring contractors) and in the ordinary way their volume is not known by the Port Authority, because they neither require any services, nor do they pass over the Dock quays or premises.

At very considerable expense, it would be possible to extract information from the Ship's manifesto, but under such conditions of the trade or a Port, a small charge is usually levied on all goods as a toll or tax for the general revenues of the Port, putting the importer or the exporter under an obligation to render particulars of his trading and to pay the charges thereby incurred. In London, this charge is known as a " Port Rate " and from the declared particulars it is possible to tabulate either in detail or simply in total, the overall trade of the Port.

Unfortunately the paper work does not synchronise with the point in time either of importation or of export. For Imports it may be some days before or some days after the event, though since most goods have to be cleared for Customs, the Import particulars are often timed to link with the Customs Entry.

Exports however are another story. The charges on small parcels may be very small, often amounting to pence only and traders to save themselves work, wait the opportunity to make a sizeable payment and defer reporting their Exports to the Port Authority.

It must follow from all this that when drawing a line, either at the end of a week or at the end of the year, we do not have the total of the Imports or Exports in the strictly legal sense: what we have are the totals obtained from the paper work and there remains an unknown quantity in suspense.

Here we are concerned not so much with an account or strict measure, except of course, so far as information is within our knowledge: we do not know the volume of this lag either in weight or in Port Rates not accounted for. In the ordinary way and taking one year with another, the quantity is likely to be small and of no statistical significance, and to adopt measures to obtain a more accurate picture, cannot be worth while.

Some Ports, particularly where the traffic passes over the quays, make a practice of publishing a statement of commodities handled during the year. While it may be desirable, if not altogether vital, that a Port should have such information available, it is doubtful whether any useful purpose is served in making it public property, though a selection of the most important may have its uses.

Comparisons with earlier periods are sometimes to be preferred if made on running aggregates over a period of say twelve months to get a better picture of the trend of business, but it must be said that the trade of the Port is often of a seasonal character. For example timber arrives with the opening of the frozen ports overseas; and there are cargoes of fruit and tropical produce of seasonal origin. This is a matter which must be left to the character of the trade handled by the particular port.

Akin to the documentation and accounting for inwards cargo, we may have corresponding information for our Exports, assuming the Port undertaking to be involved in receiving, shedding and loading. Cargo usually begins to arrive some days before the ship is ready to receive, and it has usually to be laid out in the sheds according to Port destinations and accumulated there from day to day until loading begins.

Such cargo usually arrives under cover of a Shipping Note of which there is an extraordinary variety. Sometimes there is the printed note of the suppliers who may not be the actual shippers; sometimes there is a form of Consignment Note issued by the Road Transport contractors. Shippers using the Port for the first time are often remiss in their instructions as to who is to pay the handling charges and much useless work is often involved in finding out which of several interested parties is prepared to accept the bill. We have among others: (a) the Exporters; (b) the Suppliers; (c) the Export Packer; (d) the Road Transport contractor and (e) the Exporter's Shipping Agent.

Notwithstanding that most Port undertakings specify that charges are payable before shipment, it is not often possible to enforce this requirement. In the event, it is usually made a condition of

Port Accounting—continued

shipment that upon disagreement or refusal of liability for charges by the interest stated on the Shipping Note, that the firm or interest on whose Shipping Note the goods are presented shall be liable, leaving it to that firm to determine where the liability really lies. A typical example would be a Shipping Note issued by a firm of Suppliers which instead of being claused "Charges payable by X" states that the goods are "To the order of Y." The bill of charges is sent to Y to be promptly returned with the information that the goods were bought F.O.B. and that the Supplier is the interest to whom the bill should be sent. The documentation and accounting for Exports and in particular for Export Charges is or can be very expensive and the whole procedure should be carefully watched.

Shipping Notes are expected to be presented in duplicate, one copy being signed and returned as an acknowledgment of receipt of the goods. Experience suggests that the checking of the parcels or cases should be very thorough and steps should be taken to mark both the Shipping Note and the receipted copy for subsequent identification in the event of dispute. A distinctive rotating numbering stamp is a useful device if it has a repeat trigger.

As the export cargo is taken into the shed and laid out to Port destination, the Shipping Notes are passed over to the clerk to compile the Shipping Book, which will be duplicated so that the second copy can be used later as the Mates Receipt acknowledging shipment. A loose leaf sheet (in duplicate) with the sheets indexed to Port destinations has been found very useful and much liked by Shipping Companies.

The compilation of the Shipping Book has usually a slow beginning, but the tempo increases as sailing date approaches and loading reaches a climax. This Shipping Book usually gives the sequence number of the numbering stamp and brief particulars taken from the Shipping Note with the name of the Shipper, and the Shipping Notes are then handed over to the Ship's Clerk to start on the preparation of the Manifest or for any other shipping company requirements, being returned in due course.

With the completion of loading, the Mates Receipt copy of the Shipping Book is presented to the Shipping Company for checking and acknowledgment and the top copy of the shipping Book is then sent on to the Charges section, together with the original Shipping Notes for the bills to be made out.

The tabulation of the weight column of the Shipping Book gives the measure of tonnage handled and it may be useful to obtain separately the tonnage of traffic received by Road Transport or by Rail, if the Docks are rail connected.

Complaint is sometimes made by Shippers of the delay in rendering bills for Export Charges. At certain periods delay is unavoidable, especially when business is heavy and there is possibility of cargo being shut out, because not until loading is finally completed can it be known whether some cargo may be held over and have to be transferred to another berth, thereby incurring transferring charges. Another reason is that shipments sometimes arrive as part only, in which event the Shipping Notes are expected to be marked "Part Shipment" so as to be bulked together and charges rendered at the rate appropriate for the whole. Incidentally packages are often required to be opened for Customs examination and there are usually additional charges to be levied for coopering packages so opened.

It must be left to the circumstances and conditions of each port to devise appropriate procedure, but the foregoing will have indicated some of the problems which arise and the points to be watched.

As a rule there will be no great interest in attempting a Commodity classification of Export tonnage, but it may be useful to classify the tonnage according to the class of rate charged and also, where rebates are given, for large parcels. Commodity classification is likely to be more important for Imports where, as a rule, it is more critical in rating than for Exports, but even there it is usually possible to identify the Commodity with one or other of the many Trade organisations and to tabulate as for such groups, e.g., Timber; Provisions; Dried and Green Fruit; Wine; Tobacco and so on. Such information is obviously desirable when considering applications for reductions or revisions of charges which would seem to be common experience.

The Structure of Rates and Charges

Where a Port is concerned only in providing facilities and leaves the handling of cargo to the Shipping Company, apart from the rent or hire charges made to the Shipping Company, it will derive further revenues in the form of a Wharfage charge as a toll for allowing the goods to pass over the quays. It is usually a Statutory Charge and a species of tax, because no service is rendered other than as a facility. As such it has the basic characteristic of "Ability to pay" in other words, the greater the value, the higher the charge per unit.

Of course, with the passage of time, relative values will alter and have in fact altered for many commodities, but as a rule, there is no great injustice in increasing such basic Wharfage Charges by a flat percentage when the need arises for charges to be increased to provide additional revenues, because the basic rates are of small demonination.

Much more intriguing and troublesome is the situation where the Port undertaking is involved in the handling of cargo, for the rates then consist of two components. In addition to the Wharfage Charge there is included a handling charge, which is usually of greater moment and much more liable to variation. At least that is what is assumed to be the position, though it is thought that there must be few undertakings now able to state the exact amount included in such a handling charge for the Wharfage component.

Most Port undertakings have a Rate Schedule compiled and assessed in bygone days and it is feared that they do not bear the same standard relation to the cost of handling. As Dock wages have been increased additional charges have been levied by applying a flat rate of increase, or sometimes by differing rates of increase, to the existing schedule of rates. Thus it may be an increase of X per cent. on Import Charges and Y per cent. on Export Charges and yet again by adding Z per cent. to the charges on vessels. Usually regard is paid to the incidence of the increases; those services requiring a large element of labour being asked to pay a larger relative increase than those in which labour is a smaller component.

Certainly, there is no evidence that there has been any attempt to apply an increased charge by discriminating between the several distinct rates.

From time to time, rates are wanted for the handling of new commodities, or for the handling of existing commodities under different conditions. Or there may be a desire for a Consolidated Rate to include several ancillary services. What is the best way to set about that sort of computation?

If labour is being paid by the piece, it may be assumed that there will be some guide in the existing piece rates to the operations to be performed under the new business. Or negotiations will be put in hand with the Union representatives to agree a rate for the precise operations to be undertaken. To this basic element, we will have to add some percentage X to cover the wages that are paid for non-productive time in the handling of that class of traffic, as for example, in the handling of general Imports. And we will then add a further percentage Y to cover establishment and overhead, but still distinguishing the type of service, all of which we should have if our accounts have been laid out on the plan and in the detail we have earlier discussed. We may or we may not add a specific charge to cover a Wharfage, probably depending upon the amount so reached, though we will probably have regard to ability to pay in the value of the commodity and the volume of traffic expected when we come to settle the charge.

If the service required includes a period of warehousing we should have, by the same token, information of our storage costs and the rent we must expect on the basis of the accommodation to be occupied.

In any event we shall compare the tentative rate we get by these measures, with the rates being charged for the same sorts of operations on similar commodities, unless we adopt forthwith the method of classification and bring the new business under an existing rate on grounds of similarity of requirements.

Whichever method we adopt the rates will be for services performed during normal port working time. We shall require additional charges, as incurred, for overtime working or for special facilities.

Port Accounting—continued

This outline of the approach to the determination of Dock Charges is not, of course, a hard and fast formula. In a small undertaking it may suit the case to adopt a standard rate of overhead without discrimination. Where however the Port or Dock undertaking is of larger dimensions and engaged in such varied operations as Discharging both bulk and general cargoes (using costly appliances like Grain Elevators); in handling cargoes from ships' side to Importer, often including a period of warehousing, and in receiving, shedding and trucking export cargoes, as well as loading, there is clearly an overhead differential involved and the use of dock plant and gear must be reckoned with.

Reference has been made earlier to the use of Quay cranes. In Dock working there are many other appliances, such as Floating cranes and derricks and heavy lift cranes. There may be tenants on the Dock estate who will be requiring Haulage along the dock railways. Fork lift trucks and portable cranes are often hired to Shipowners.

If the port undertaking engages in Salvage and Wreck Raising for the clearance of obstacles, large and expensive units may be involved such as wreck lighters, camels, pumps etc. for which it is very necessary to determine use rates so as to be able to satisfy the Assessors or Adjusters who may be expected to probe very carefully the charges that come to be rendered. Obviously for such purposes a simple overhead percentage for the whole undertaking is not likely to be accepted.

Now and again plant is hired out on a "bare" basis: that is without labour or supplies. Provided the hirers are traders or regular users of the Port, it would be proper to assess a charge calculated upon the debt service charge applying to the particular unit, coupled with the average maintenance costs, with a nominal addition of, say, 10 per cent. as a contribution to overheads, but if there is no such relationship, one could, not unreasonably, expect a higher loading so as to give some semblance of gaining a profit. Transfer costs would, of course, be in addition, and so too any damage suffered. Usually too there would be inventories out and home to account for any stores, materials or gear taken over and returned.

Another typical example would be the hiring of a Dredger for out of port working. Usually that would be with the full complement of dredger men at an inclusive charge of so much per day. But instances are not unknown of dredging being undertaken on a contract for measured spoil removed. Naturally such prospective work will call for the closest collaboration with the Engineer in fixing a price, after a survey of the site and the hazards of the operation.

However, no Port is in business as a Dredging Contractor and it may well be ultra vires and only justified by an emergency for such work to be taken on.

The discussion of these considerations and the outline of the formula or method that might be adopted, are not to be taken as inviolate. In all this we ultimately come back to the Operating Statement which, if properly understood and regularly compiled, should leave one in no doubt or difficulty, since it contains all the information that will ordinarily be required for fixing charges for plant user.

Where labour rather than plant or equipment is the predominant element of the operation, we shall nevertheless look to the Operating Statement for information or guidance on our overheads. And of course it is not to be taken for granted from anything that has been said here, that the fixing of charges is a function of the Accounting organisation. Accounting is a "passive" function, whereas the fixing of charges is an "active" function; the one is as before the event occurs, whereas the other follows after the event. The Accounting organisation is there to assist the Management by providing the information which is indispensable for the fixing of charges.

Current Cash Position

We have been considering so far the sort of information that could be useful to the Management of a Port undertaking using "management" in its strict sense as the direction of the day by day operations. But there will also be information to be supplied to the Board as the Governing body. Some of this will relate to current affairs and some will be to assist in the determination of policies for the future progress.

Firstly let us look at Finance. The Board will require to know currently the liquid position of resources in Cash, Bank Balances and short dated securities. A simple Cash Summary bringing forward the balances from the last account and showing in aggregate the receipts and payments on both Capital and Revenue Account, with extraordinary items or transfers from the one slate to the other, is likely to suffice.

The Board (or its Committees) will usually be directly concerned in the detail of the disbursements. A list of accounts for payment will be prepared and submitted to a sub-committee with the appropriate vouchers and if in order will be passed for payment. On the authority of this list, cheques will be drawn and authenticated with the signatures of two of the Chief Officers, say the Secretary and the Chief Accountant or by other senior officers acting for or representing both Chief Officers.

An Imprest Account will almost certainly be required for Emergency payments and for such current payments as Wages and Salaries. Such an amount as is likely to cover these forms of payment arising between one meeting of the Board and the next, will be set aside in an Emergency Account and it will be reimbursed on presentation of the payment vouchers at the next meeting. It would be a rule that the Emergency account was not to be overdrawn without the sanction of the Chairman of the Finance Committee or other appropriate Board member in his absence.

Some indication of the future cash position is also likely to be required and particularly so if new works are in progress, for which purpose an estimate of receipts and payments looking forward, may be, for the ensuing six months should be satisfactory. The expected receipts and payments on Revenue account may call for collaboration about the volume of trade, but the receipts on Capital account will largely fall upon the Chief Engineer according to the progress which the works are planned to achieve.

Depending upon the position shown by this statement decisions will have to be taken by the Board to realize Short dated securities; to negotiate for a Bank overdraft (though there will usually be standing arrangements for this) to have recourse to other forms of temporary borrowings, such as Bills and Bonds, or finally to fund the whole of the requirements by a Market issue of Port Stock or other such permanent capital funds.

Contrariwise surplus cash may be set to work by investing in anticipation of Sinking Fund obligations, or putting the money on deposit or yet again in buying Short dated securities or in other ways which may present themselves from time to time. Quite often these and such matters are left to be settled with the Chairman of the Finance Committee, especially for the purchase of securities when it may be important for prompt action to be taken.

While there may not be a thorough going budget for all the activities of the undertaking, it is more than likely that there will be a budget or an allocation for all new works and for repair and maintenance and may be also for dredging. In that event the Board will expect a periodical report of progress. For works of either category, i.e. capital works or revenue works, in so far as these are carried out by contract, there would of course be no difficulty in reporting and aggregating payments on account, but as earlier mentioned, there is likely to be work awaiting measurement or other form of certification and unless these are taken into consideration, which is not possible intermedially except as a rough estimate, judgment on the progress of the financial budget must have a reservation.

Nevertheless the attempt should be made at least once a year, preferably at balancing the year's accounts, to size up these outstanding obligations, so that they may properly be brought to account.

Some Boards may be interested, as a current feature, in the state of the debtor balances, not so much in their detail as in the aggregate and in its progress. To this end a Statement or Return giving the relative information for each of the last thirteen months inclusive of the month of the Return, will give a comprehensive survey if tabulated with columns such as follows:

Port Accounting—continued

Month.
Balances at last account.
Debits during period.
Cash and other credits during period.
Balances to next account.
Ratio of current balances to last month's debits.
(or alternatively period of credit in days, represented by balances on scale of last month's business).

In this manner we get a comparison with the current month and its antecedent a year ago, as well as a successive report for the intervening months. Each month we have but to add one month to and to deduct one month from the last Return. As well as being interested in the trading revenues, the Board are also likely to be interested in the volume of trade as represented by the Shipping and Goods moving through the Port. To this end the Returns which have been considered earlier for management purposes may be assumed to find their way ultimately to the Board's Agenda for each meeting.

From time to time other information will be required as special reports dealing with various aspects of the Board's policies and problems. For example in considering proposals for new works, some estimate of the effect on the revenues. Usually these are matters for collaboration with other officers, in which the accounting organisation will be expected to report on ways and means and on the effect of the charges for debt service.

Pneumatic Breakwater Trials

Full Scale Test at Iwojima*

In the winter of 1955, a full scale experiment of a pneumatic breakwater was carried out at the Iwojima Islands off the harbour of Nagasaki in the period of the seasonal wind. The limit of the air supply available for the experiment was 30 m^3/min., so having waves up to 15 metres in length as the object to be annihilated, a perforated pipe 30 metres long was installed at the depth of 18 metres beneath the lowest water level, the tidal range being 3.5 metres.

A commercial pipe of wrought iron, 3-in. in diameter, having the holes, 1.5 mm. in diameter, in the ratio of 35.7/metre was suspended in the sea about 20 metres deep in such a manner that the prescribed depth of the pipe would be preserved.

Waves were recorded in the rear of the pneumatic breakwater before and after the air injection. The wave recorder used was a Froude's wave height recorder equipped with two resistance wires. The recorder drifted out of the prescribed position by the surface current at the time of air injection to a distance of 20 to 30 metres behind the perforated pipe.

On calm days, the velocity distributions of the surface current induced by the air injection, were measured in the vertical and the horizontal directions using an ordinary current meter. The measured velocity distribution was proved to be of the same nature as that obtained in the laboratory. Especially for the vertical distribution the similarity throughout each section was observed.

As the result of these tests it was verified that the installation possessed the performance which was expected of it from the model experiments previously performed in the laboratory.

Wave Reduction Tests.

Tests were made on days when conditions were favourable and the waves, original and reduced, as well as the wind velocity, the wind direction and the tidal level were recorded for several air consumptions.

For two typical tests Fourier analysis was carried out in order to compare energy spectra of the waves. From each of these calculations it was estimated that the powers of 1.01 and 1.13 kw./m. would be needed to annihilate practically the waves of 3 seconds of period.

These numerical values are less than, but nearly equal to, the theoretical least power of a pneumatic breakwater predicted on the basis of the wave-stopping action of the horizontal current, namely

$$P = .002 \times \lambda^{2.5}$$

where P is measured in kw./m. and λ, the wave length, in m.

Because the perforated pipe was not sufficiently long in comparison with the wave length, diffraction of waves at both ends of the pipe was quite sensible, and gave rise to difficulties in interpreting the results of the test. An experiment in the model basin was therefore performed under conditions completely similar geometrically to those of the full scale test. It was concluded by this means that the wave height could not be reduced below about one-half even in the case when it would have been annihilated completely, provided the air consumption was sufficient and the diffraction negligible.

Judging from the measurements of the surface current, the efficiency of the bubble jet in the present test cannot be said to be high compared with that of the model basin experiment which is about 0.25. Yet the fact that the power necessary to annihilate waves is less than the value predicted, suggests that not only the horizontal current but also, under natural conditions, turbulent viscosity plays an essential role in wave reduction. In fact, in the two examples referred to above, the wave period was found to be 3 seconds, the wave length 14 metres and the air consumption 15 litres/min. The maximum velocity of the current induced for this air consumption is estimated to be approximately 60 cm./sec., only 13 per cent. of the wave velocity. In this case the horizontal current is far from being capable of stopping the transfer of energy of the waves.

Conclusion.

The theoretical relationship between the wave length and the power has been verified approximately for waves of the order of 3 seconds period. The mechanism of wave annihilation of an actual pneumatic breakwater, however, has been revealed to be due not chiefly to the surface current, as believed generally up to the present and perhaps true for a small scale experiment in a laboratory, but rather to the turbulent viscosity accompanying the surface current. The former has the effect of magnifying the action of the latter.

* Summarised from an English abstract of a paper which appeared in Bulletin of Research Institute for Applied Mechanics, No. 7, 1955, Kyushu University, originally written in Japanese.

Errata

Our attention has been called to errors in the two following articles. We are therefore publishing corrections with apologies from the authors for any inconvenience caused.

IJmuiden Radar Station.

At the conclusion of the article on "Harbour Radar Installation at IJmuiden," which appeared in the February, 1956, issue of this Journal, it was stated incorrectly that the IJmuiden Radar Station was the first of a chain of radar stations which would monitor the passage of ships from the North Sea to Amsterdam.

In fact, the IJmuiden Radar Installation operates at the entrance to the North Sea Canal, which leads to the Port of Amsterdam and is not equipped with radar stations. However, the canal leading to the Port of Rotterdam, the New Waterway, is now being equipped with seven harbour radar stations which will monitor the passage of ships all the way from the North Sea (Hook of Holland) to their berth in Rotterdam. (It is hoped to print a description of this chain of installations in "The Dock and Harbour Authority" later in the year.)

Reducing Harbour Swell at Exmouth.

In this article, which appeared in our March issue, the name of the Manager of Exmouth Dock Company was incorrectly given as G. M. Young when in fact, it should have been Mr. G. M. Thomson.

In the penultimate paragraph of the article, it is stated that "the resultant wave and swell inside the dock is between 80 and 90 per cent. of what it was before the barrier was constructed." The word "resultant" should have read "reduction in."

Sextant Graph Plotting Sheets for Fixing by Horizontal Angles

Method of Construction by Computation

By Lieut.-Commander GEORGE CROOK, R.D., R.N.R. (Retd.).
(Mersey Docks and Harbour Board).

A PLOTTING SHEET for fixing by horizontal angles without using a station pointer consists of two families of intersecting lines each family being based on a pair of well conditioned objects between which the horizontal angle is to be observed.

Considering each family of lines separately it is required to construct on a suitable surface such as cartridge paper for use in a surveying vessel or metal plate as a permanent original in the drawing office, a family of lines drawn to a suitable scale such that from every point on each particular line the horizontal angle subtended by two well defined objects is the same.

From the theory of the station pointer fix contained in almost every text book on navigation or hydrographic surveying, it is primary knowledge that these lines are arcs of circles.

The methods of plotting these arcs fall generally into two classes:—

(A.) Methods which involve distances which have to be plotted relative to the objects to be observed, and

(B). Methods which depend primarily on calculation and in which the plotting required is confined to the area covered by the plotting sheet and in which the distances involved are small

If the surveying site is some distance away from these objects and the scale is relatively large then the distances involved in A. become too large to be plotted and use has to be made of B.

Method A.I.

Consists of plotting throughout using the

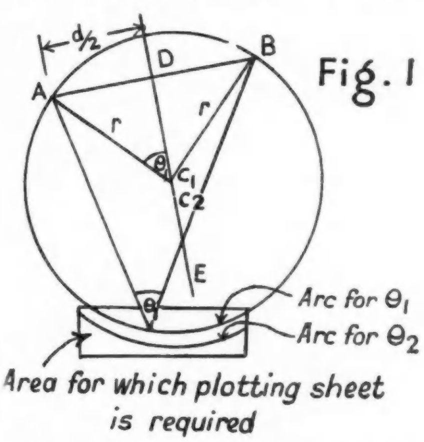


Fig. 1

A. and B. are the two objects, between which the horizontal angle (Θ) is to be observed as one angle of the fix, and the distance between which (d) is known.

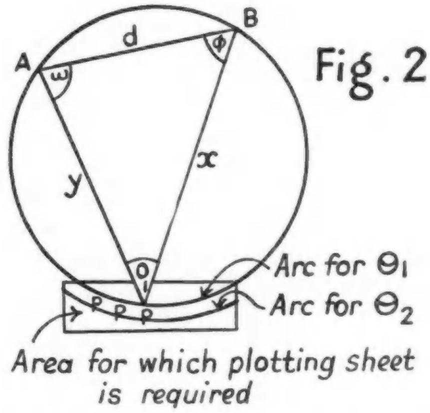


Fig. 2

A. and B. are the two objects, between which the horizontal angle (Θ) is to be observed as one angle of the fix, and the distance between which (d) is known.

geometrical methods outlined in the theory of the station pointer fix. No further comment is needed here except to say that, whereas it is, generally speaking, unsuitable for surveying purposes, it can be used with great advantage on Admiralty charts for navigation in coastal waters and for manoeuvring in harbour when picking up a predetermined anchor berth.

Method A.II.

Consists of calculating the positions of the centres of the circles and their radii, and then scribing the arcs by beam compasses. (See Fig. 1).

It is usual to plot the centres of the circles by constructing DE, the bisector of AB, as the locus of centres and then plotting DC_1, DC_2........DC_n, where C_1, C_2........C_n, are the centres for arc θ_1, θ_2........θ_r, of radius r_1, r_2.........r_n.

When $DC = \frac{d}{2}\,\text{Cot}\,\theta$ and $r = \frac{d}{2}\,\text{Cosec}\,\theta$

C_1, C_2.........C_n could be plotted by scribing r with beam compasses from A and B. This would not in general be as accurate as plotting C by above methods but affords a valuable check.

Method A.III.

Consists in calculating the positions of points, P, on each arc in terms of the distances from the two stations to be observed, plotting these positions and then plotting the arc through them. (See Fig. 2).

For each point P on each arc a suitably smoothed distance y (obtained approximately from a small scale chart) is used to calculate the other distance x from

$$x = \frac{d\,\text{Sin}\,\omega}{\text{Sin}\,\theta}$$

$$\text{where Sin}\,\phi = \frac{y\,\text{Sin}\,\theta}{d}$$

$$\text{and}\ \omega = 180^\circ - \theta - \phi$$

The two distances are then plotted for each point P from A and B and the area plotted by railway curves after calculating the radius as in A.I. It can be argued that as in A.I., the radius has to be calculated and comparatively long distances may have to be scribed, and that therefore method A.I should be used, when then added accuracy of scribing the areas by beam compasses can be obtained as opposed to plotting them by railway curves.

Method B.I.

Consists of calculating the positions of a series of points on each arc in terms of bearing and distance from one of the objects to be observed. Then knowing the rectangular co-ordinates of that point, the rectangular co-ordinates of each point P can be obtained and plotted. (See Fig. 3).

For each point P on each arc a suitably smoothed angle ω can be used to calculate x from:

$$x = \frac{d\,\text{Sin}\,\omega}{\text{Sin}\,\theta}$$

Knowing the bearing of BA the bearings of BP (δ) can be obtained by applying φ where $\phi = 180^\circ - \theta - \omega$ then

$$\delta N = \pm\ x\ \text{Cos}\ \delta$$

$$\delta E = \pm\ x\ \text{Sin}\ \delta$$

where δN and δE are the distances N and

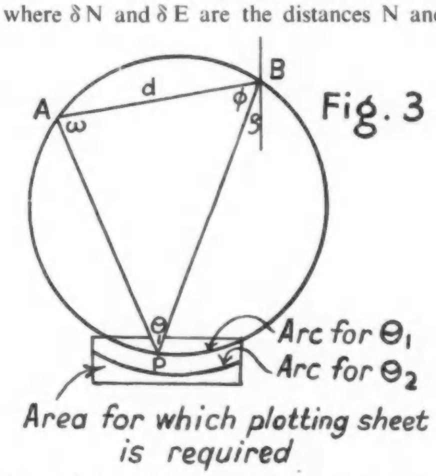


Fig. 3

A. and B. are the two objects, between which the horizontal angle (Θ) is to be observed as one angle of the fix, and the distance between which (d) is known.

Sextant Graph Plotting Sheets—continued

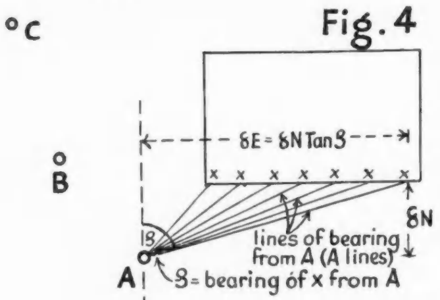


Fig. 4

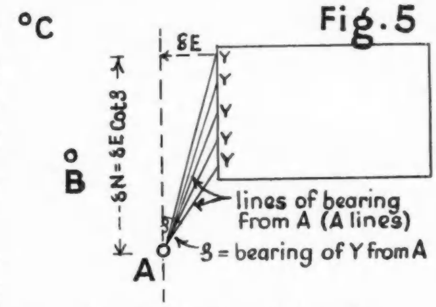


Fig. 5

A. B. and C. are the objects between which the horizontal angles will be observed to obtain a fix

E respectively of P from B δN and δE can then be applied to the rectangular co-ordinates of B and the rectangular co-ordinates of P obtained.

This method lends itself to quick and easy manipulation by calculating machine and natural functions since all angles except δ are in whole degrees—Chambers tables can be used for these angles. For sin δ and cos δ seven or eight figure natural tables to seconds of arc are needed and Peters eight figure tables are admirably suited, one opening sufficing for both quantities. This way, no difficulty has been experienced in completing six calculations for P in twenty minutes.

By drawing the arcs geometrically on a small scale chart prior to calculation, the limiting values of ω are easily determined.

After the rectangular co-ordinates of each point P have been determined it is a simple matter to obtain the plotting distances from the nearest South West grid intersection and having determined the various radii as in A.I to choose or construct an appropriate curve for scribing the arcs. No great accuracy is necessary when constructing such a curve since when radii are great—say 5 to 10-ft.—curves differ but minutely for each inch increase of radius.

Method B.II

Consists of constructing within the area under consideration a series of lines of bearing from each object to be observed, and from the difference in bearing constructing arcs of equal subtended horizontal angle. (See Figs. 4 and 5).

From a small scale chart lay off a number of suitably spaced bearings from A so as to cut one or more boundaries of the area under consideration. It is required to calculate the positions of the points of intersection

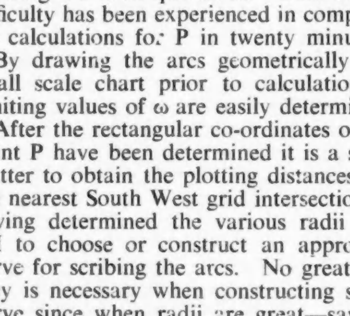


Fig. 6

of these lines of bearing with the boundaries. Knowing the co-ordinate values of A and of the four boundaries the position of each point X can be calculated.

from:—

$$\delta E = \delta N \text{ Tan } \delta$$

(Fig. 4)

and each point Y from $\delta N = \delta E \text{ Cot } \delta$

(Fig. 5)

When this has been done for opposing boundaries the intersections (X or Y) are joined up to give a family of lines of bearings based on A (A lines) (Fig. 6).

The same operation is then carried out for object B to obtain B lines so that two families of bearing lines are obtained (Fig. 7).

Now the angle of intersection (θ) between the A lines and B lines at any point C is the difference of bearing between A and B, i.e.

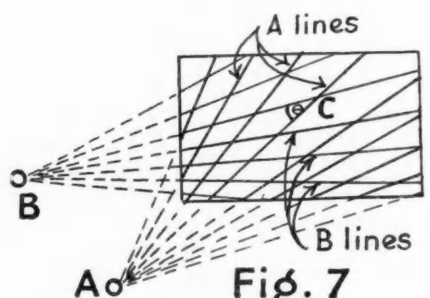


Fig. 7

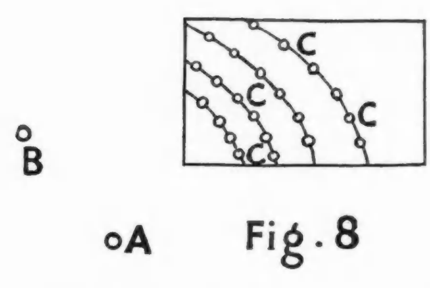


Fig. 8

it is the horizontal angle subtended by AB at C. If all points C (Fig. 8) having the same value are now joined they will lie on an arc of radius $r = \frac{d}{2} \text{ Cosec } \theta$ which can be calculated on a slide rule with sufficient accuracy for determining which curve to use. Thus one family of arcs has been obtained relative to A and B. The same process is repeated to obtain the second family relative to B and C.

The advantages of this method are that tedious calculations are reduced to a minimum, there is no loss of accuracy, and it is exceedingly simple. The disadvantage is that the angle of cut between the lines of bearing may sometimes be small and make exact plotting of point C impossible. In this case method B.I. should be used.

N.B.—As a check on the accuracy with which the A lines and B lines have been plotted intermediate points X_1 and Y_1 can be calculated (Fig. 9).

Rectangular Co-ordinates not Available.

If rectangular co-ordinates are not available for the area under consideration several methods can be used for the calculation of the position of points on their respective arcs, which points can then be joined up by railway curves. These methods, however, tend to be unwieldy and tedious and it is a much better and neater method to construct a grid of rectangular co-ordinates for the area, using one of the objects to be observed as the origin, and giving it a value of, say, 100,000 n; 100,000 E, to avoid any subsequent negative values and then using either methods B.I and B.II.

Intermediate Arcs.

After arcs have been calculated and plotted on the desired scale it may be found that it is desired to plot intermediate arcs.

Now intermediate arcs are not midway between adjacent arcs. Their distance from adjacent arcs depends on the value of θ and the ratio obtained from the table below.

To plot the arc $(\theta - 1/2^\circ)$, measure the shortest distance apart at any suitable point of arc θ and arc $(\theta - 1^\circ)$, and multiply by the appropriate ratio from the table below to get the distance of arc $\theta - 1/2^\circ)$ from arc ø.

Repeat at suitable intervals when arc $(\theta - 1/2^\circ)$ can be plotted by joining the points by an appropriate railway curve.

If the ratio for the area under consideration is constant a proportional scale can be constructed to facilitate the work.

The ratios given in the tables only strictly apply where arcs have been plotted for every degree and interpolation is for the intervening half degree but there will be no plottable error by using them up to an interval of at least 4° for the intervening 2°.

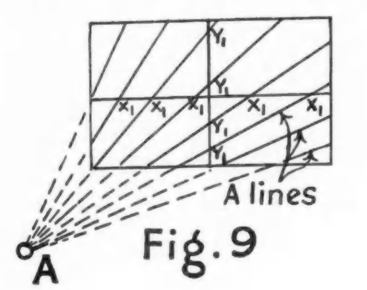


Fig. 9

Sextant Graph Plotting Sheets—continued

θ	Ratio
10°	$\frac{1}{2.14}$
20°	$\frac{1}{2.06}$
30°	$\frac{1}{2.03}$
40°	$\frac{1}{2.03}$
50°	$\frac{1}{2.01}$
60°	$\frac{1}{2.005}$
70° 80° 90°	$\frac{1}{2.00}$

The derivation of these ratios can readily be calculated.

Advantages and Disadvantages.

The main advantages of this type of plotting sheet are:—

(a) The fix is in general plotted much more quickly and accurately than with a station pointer especially at large distances.

(b) The objects chosen for observation to give the two angles need not be limited to three adjacent objects as in a station pointer fix but can also comprise two well conditioned pairs of objects.

(c) Any subsequent distortion in the plotting sheet does not affect the accuracy of the plotted fix as with a station pointer.

The main disadvantage is that observations are limited to objects for which the plotting sheet has been constructed when at times it might be desired to observe others instead of or in addition to those used in the construction.

Summary.

The above methods have described how to construct a series of circles such that from every point on each arc the horizontal angle between the two chosen objects is the same.

It is probably unnecessary to say that for a fix two observed angles are needed and that consequently on the plotting sheet two such families will have to be constructed.

Further, the area for which the sheet is constructed will have to be related to its neighbouring areas and the larger area within which it is contained. For this purpose objects common to the area of the sheet neighbouring areas, and to the whole, will also have to be plotted on the sheet. If no natural common objects exist artificial plotting points will have to be defined and plotted. Indeed when natural objects do exist it is often advantageous to create well conditioned common plotting points in addition.

The above methods do not pretend to be the only ones available. Other methods known to have given satisfactory results consist of:—

(a) Calculating the positions of intersections of left and right arcs for suitable angle values in terms of bearing and distance from one of the objects and plotting by rectangular co-ordinates. This method, however, tends to be rather long and tedious and has therefore been omitted.

(b) Developing the formula for a circle $r^2 = x^2 + y^2$. Needless to say this leads to squares and square roots which do not lend themselves to speedy calculations. Nevertheless this is a rather neat theoretical method.

Of the above methods A.II and B.II are the easiest to handle in practice but whichever method is chosen a calculating machine and a set of tables of seven or eight figure natural functions to seconds of arc relieve the calculations of much of their boredom.

Port of Durban Improvements

Tanker Turning Basin Nearing Completion

According to reports in the South African press, a 1,000-ft. turning basin for tankers at Island View, Durban, and the reclamation of 27 acres of land at the western end of the present line of wharf is expected to be completed shortly. During the past two years, steady progress has been made with both works, which are closely related, the spoil from the dredging being used for the reclamation of the land. Their completion will mark the end of one of the largest development works undertaken in Durban harbour for some years.

When work was started on the dredging, it was estimated that it would cost £261,000, but, as a result of a modification to the original plan, there has been an appreciable saving in cost. The total area has now been cleared, with the exception of a few patches of hard sand which will be removed gradually. Over the whole area, with the exception of the patches, there is now a depth of 36-ft. at low water which is sufficient to permit the deepest draught tankers calling at the port to be turned in the basin.

Originally designed to cope with large tankers of up to 32,000 tons, the new basin will permit craft of this size to turn with ease. Up to now all large tankers of 600-ft. in length and more were taken to the discharge berth stern first in order to avoid having to be turned in the existing channel.

From the time that operations started, work has proceeded smoothly. The most difficult problem was encountered when working on the fringes of the mangrove swamp into which the basin extended. Here the matted roots of the mangroves tended to block the intake pipe of the suction dredgers. To overcome this, a grab dredger was employed to bite through the layer of matted roots and when this had been done, the suction dredgers were able to operate.

Of the 27 acres which have been reclaimed, more than two-thirds of the land has been covered with ash to prevent wind drift of the top layer of soil. During the time reclamation was in progress, an average of three loads (about 9,000 tons) a day was maintained, and on one day one of the dredgers established a record when nine loads were pumped ashore. On this occasion, however, sand was running well for the craft and conditions were ideal.

Wharf Extension.

In addition to the dredging and reclamation works, good progress has been made with the 400-ft. extensions to the wharf, and work has now commenced on the reinforced concrete platform between the two caissons forming part of the extension.

The platform has been designed to carry the pipes used in loading ships with refined products from the Wentworth Refinery. In addition, it has been strengthened so that, should it be necessary in the future to erect a second hose tower similar to that used at No. 4 Island View, where crude oil is discharged, this can be done without delay.

Other work now being carried out by the Harbour Engineer's Department is the strengthening of Maydon Wharf at the Grain Elevator so that the heavier shunting engines now in use can operate on the wharf. At present it is not strong enough to take this type of locomotive. In the near future work will start on the construction of eighty 30-ton concrete blocks as a reserve for the South Pier. When completed, they will be available to replace damaged blocks or those moved by heavy storms.

Dredging of Sunderland's Harbour Entrance.

The River Wear Commissioners have recently announced that dredging will take place of Sunderland's harbour entrance from June to October this year. The scheme to straighten and deepen the channel was begun in 1938 but, because it is a rock dredging operation, work can only be carried out during calm weather, and there are only about 30 to 40 days of the year when the weather is suitable. The straightening of the channel and part of the deepening is completed, but it is estimated that it will take another five years to finish the scheme, and even longer if bad weather delays the scheduled programme.

The Great Ouse Flood Protection Scheme

Drainage and Engineering Works in the Fens

By W. E. DORAN, O.B.E., B.A.I., M.I.C.E.

IN July, 1954, there was commenced, near King's Lynn in Norfolk, the largest drainage scheme to be done in England in the past three hundred years.

This scheme, known as the Great Ouse Flood Protection Scheme, will probably cost more than £8 million and may take eight or more years to complete.

The first large scale drainage of the Fens was carried out by the Dutch Engineer Sir Cornelius Vermuyden for the fourth and fifth Earls of Bedford and their thirteen co-adventurers between the years 1630 and 1652.

The two main features of Vermuyden's scheme, which is shown in Fig. 1, consisted of the cutting of two straight rivers 20 miles long between Earith in Huntingdonshire and a point near Denver in Norfolk to by-pass the loop of the river Ouse round by Ely and give the waters of the Bedfordshire Ouse a straight passage to the sea. Between these two new rivers Vermuyden left a flood plain of "washland" about $\frac{3}{8}$ mile wide to serve the double purpose of storing flood waters and providing a small surface gradient through the twenty miles of level fen land. Secondly, he built a sluice across the Ely branch of the river at the point where it joined his new cut, so as to keep out the tides. By these means he shortened the course of the Bedford Ouse to the sea by about 10 miles, he halved the flood discharge to be carried by the old course of the river via Ely and, by excluding the tides at Denver sluice, he avoided the necessity for constructing embankments high enough to contain the tides on the Ely Ouse and its tributary rivers, the Wissey, Little Ouse, Lark and Cam. He also avoided the drainage difficulties which would have been caused by the diurnal rise of tides in those rivers.

Vermuyden's scheme accomplished its object, and swamp and marsh yielded place to corn and lush grass.

Triumph was short lived however. There began the process which has continued ever since—the shrinking of the peat.

The moisture content of waterlogged peat may be as much as 800% and when it is drained the immediate effect is a shrinkage of the top layer from which the water has been abstracted. This initial shrinkage may be more than a foot in the first year. This is followed by the oxidation of the dried surface, which results in further wastage. Loss from this cause, which continues so long as the peat is dry, may be one or two inches a year.

It was not long, therefore, before lands which drained freely into the rivers became wet and badly drained, whilst the rivers themselves seemed to flood much more frequently.

Small flood banks had to be made to keep the floods off the land, then horsemills, then later windmills, had to be put up to pump the water from the drains into the rivers.

Thus began the separation of the fenland drainage network into two systems, a high level system carrying the upland rivers through the fens and low level systems carrying the drainage water to the mills or pumps.

Our present system of fenland drainage districts no doubt had its beginnings in the association of farmers for the purpose of erecting drainage mills for their lands.

Modern pumping plant driven by diesel engines or electric motors has solved the problem of fen drainage.

The peat fens, however, have continued to sink and to waste away at an ever increasing rate.

Mean sea level, which governs the level of the rivers, has not fallen, it has risen perhaps 3-ft. since the fens were first drained, and so the height of the river embankments has continuously increased.

Parts of the fenland are as much as 5-ft. below mean sea level; high flood level is 12 to 13-ft. above it.

Our problem is not fen drainage, it is the protection of the fens from flooding by the failure or overtopping of the river embankments.

This suggests that the remedy is to make the flood banks high enough and strong enough to contain the floods. Alas, the solution is not quite so straightforward; another kind of fenland soil comes into the picture—the "buttery clay." "Buttery clay" is an apt description of the soft, silty clay which overlies most of the fenland floor beneath the upper coating of peat or silt.

From surface level to the hard Kimmeridge clay, gault or chalk may be as much as 15 or 20-ft.; even more in a few places.

The flood embankments rest, one is inclined to say they float, upon the peat and buttery clay layers (see Fig. 2).

This affects them in three respects, liability to sinking, stability, and seepage underneath them.

The flood banks sink as the peat and the soft clay consolidate slowly under their weight. As they sink the safe margin above flood level (freeboard) diminishes and they have to be heightened. The weight of the clay added to them in the heightening starts off a new sinking process—and so on.

In the South Level, an area of about 189,000 acres, lying between the New Bedford, or Hundred Foot, River and the uplands of Norfolk, Suffolk and Cambridgeshire, and which is the area mainly threatened in times of high flood, there are some 190 miles of flood bank. In the past thirty-five years about £1½ million has been spent, principally in trying to keep pace with the rate of sinking of the embankments, without, however, succeeding at any time during that period in getting them up to a standard sufficient to withstand high flood levels with safety.

The disastrous floods of 1947, when 37,000 acres in the fens were flooded, showed how inadequate were the flood defences notwithstanding the very large expenditure incurred.

It is estimated that at the present time an expenditure of about £120,000 per annum is required to keep pace with the sinking of the South Level embankments.

It is not possible to contain a flood of the 1947 category within the flood banks of the South Level and the standard used for bank design is the flood of 1937, which is considered to have a frequency of four per century.

The minimum desirable freeboard above high flood level is 2-ft. Each time a flood bank is heightened the initial consolidation of the underlying peat and soft clay results in a rapid loss of height. The amount of this loss varies a good deal, of course, but where there is a considerable depth of peat and buttery clay a bank heightening of 2-ft. 6-in. may result in a loss of 12-in. in the first year, so that if the bank was at zero freeboard nearly half the amount gained has been lost in twelve months. The rate of loss decreases very much after the initial period and the average over a period of six or seven years may be about 3-in. per annum.

The wastage of the peat surface behind the flood banks, which may be one or two inches a year, constantly adds to their virtual height.

It is obviously impossible to heighten the banks continually without a corresponding increase in the width of the base. This brings us to the second problem—stability.

The weak fen clays and peats will not withstand too heavy a load and if too much is added at a time a slip will occur. With high banks it is the practice to build a well consolidated berm behind the bank one year and to carry out the heightening the next.

There is, however, a limit to the amount by which the banks can be heightened. Usually not more than 2-ft. 6-in. is added at one operation. The presence of roads, drains and buildings create special obstacles to the widening of banks in some places.

The third problem mentioned is the seepage which takes place where there is much depth of peat or where sands or gravels are encountered. This is dealt with by a cut-off trench filled with clay. For practical reasons, however, it is seldom possible to excavate a cut-off trench deeper than 10-ft. and this may not be sufficient to get to the bottom of the peat stratum.

The Great Ouse Flood Protection Scheme—continued

From what has been said, it will be realised that it is not possible to overcome the flood danger by raising the flood banks.

If the banks cannot be raised, can the flood levels be lowered?

Before going on to consider the solutions which have been suggested to this problem, two further difficulties must be mentioned; tidal levels in relation to bank heights and the heavy silt load carried up the tidal section of the Ouse from the Wash.

Referring to Fig. 1, it will be seen that the main river Ouse flowing from Northants, Bucks, Beds and Hunts meets the flow from the Eastern catchment, which takes the drainage from part of Norfolk, Suffolk and Cambs, at Denver sluice, the Eastern catchment being, in fact, slightly larger than that of the Bedford branch of the Ouse. The tide is excluded from the Ely branch of the Ouse by Denver Sluice, but it exerts its influence for the whole length of the Hundred Foot.

During flood periods, the greater part of the flood waters of the Bedfordshire Ouse pass down the washlands between the Hundred Foot and Old Bedford rivers and are discharged into the river through Welmore Sluice, about two miles above Denver, the excess of input over output being stored in the washlands. As the tide ebbs on the downstream side of Denver Sluice, the discharge down the Hundred Foot maintains the river at a level which is high relative to the waters of the Ely Ouse impounded behind Denver Sluice.

The amount evacuated on each tide becomes less than the input and water levels rise steadily behind the sluice.

In the floods of 1937, the water level at Ely rose to about 3-ft. above the "safe" retention level of the banks and, indeed, was above bank top level along miles of bank, held only by a precarious line of hastily placed bags. In 1947, the levels rose until the breaching of the banks in many places halted the rising water level.

Here then is a problem indeed. High tide we cannot control; low water level we might perhaps improve if we could so widen and improve the tidal Ouse that a flatter surface gradient produced a lower water level at Denver. Here again we encounter a major obstacle in the silt laden tidal waters. Apart from the great physical difficulties of widening and deepening the tidal river, the flood tides carry with them from the Wash such quantities of silt that the river would silt up almost as quickly as it could be dredged.

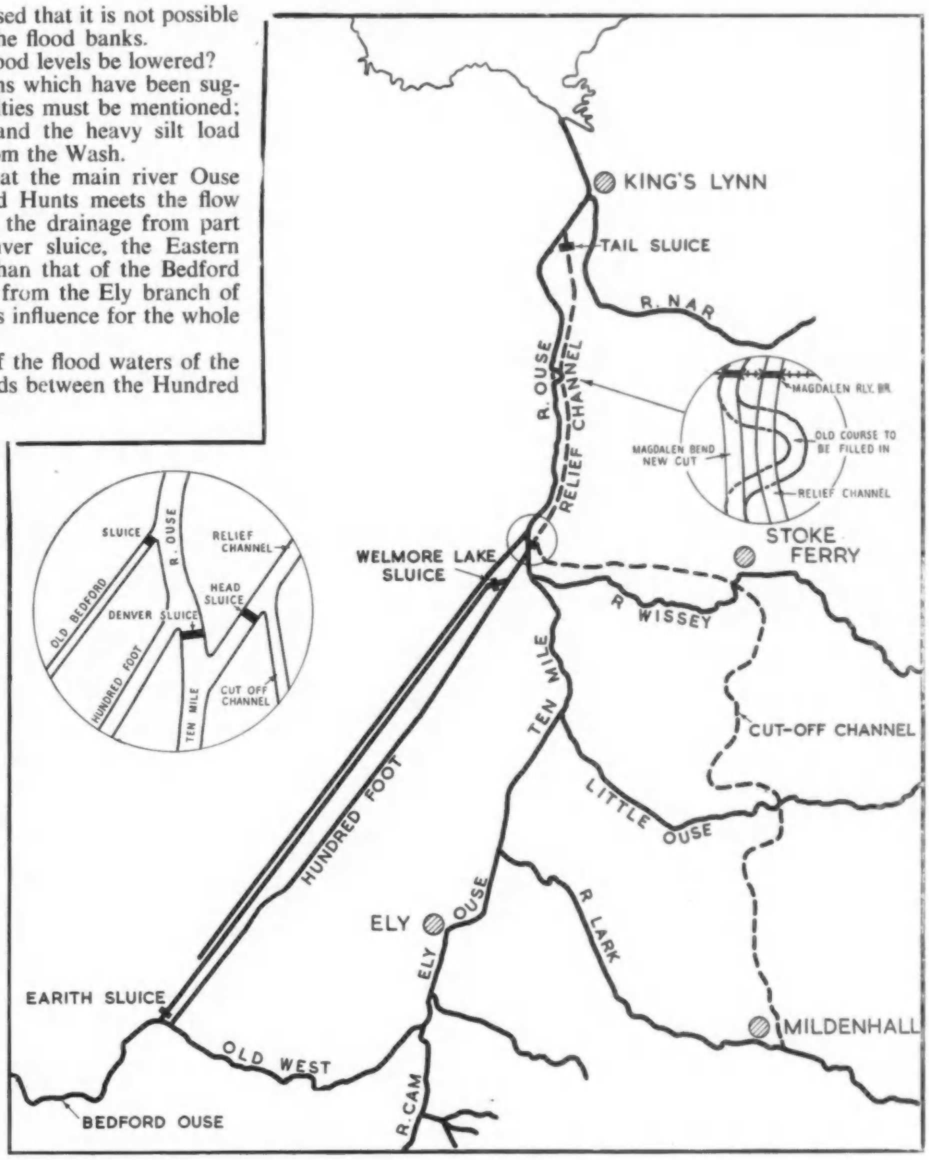


Fig. 1. The Fenland River System.

This problem has been the subject of arguments, counter arguments and disputes at intervals since the seventeenth century.

The real nature of the problem was not appreciated by the numerous writers on the subject. The literature on fen drainage abounds with references to the state of " the outfall."

The water was not " getting away " and it seemed that the trouble must be in the bad state of the outfall in the Wash.

It was felt that if this could be cured, all would be well.

It was evidently not realised that Sir Cornelius Vermuyden had given the solution of the problem nearly three hundred years earlier! (Fig. 3).

Schemes for the improvement of the outfall by means of a trained channel were put forward by W. H. Wheeler, 1884, A. H. Case, 1917, Joint Select Committee of the Houses of Parliament, 1927, and J. Kraaijeveld, 1930.

It can be said that none of these schemes would have been effective. It is perhaps significant that although the most hazardous and costly works were recommended, no calculations were

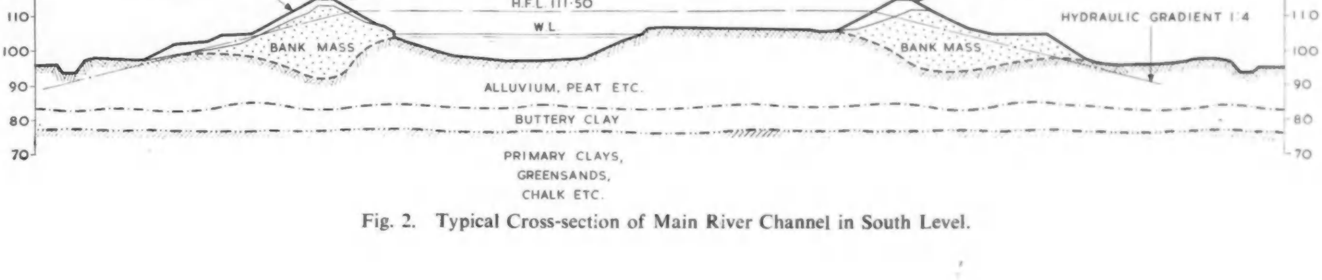


Fig. 2. Typical Cross-section of Main River Channel in South Level.

The Great Ouse Flood Protection Scheme—continued

produced to show the amount of lowering of the flood levels that could be expected in the South Level.

The major problem of the maintenance of the sinking flood banks and the wastage of the peat fens was ignored, as was the lack of capacity of the South Level rivers.

This preoccupation with the outfall has played no small part in the lack of technical progress with the fen flood problem during the past fifty years.

After the disastrous floods of 1912, the Board of Agriculture and Fisheries caused a report to be made on the condition of the rivers and the cause of flooding. This report was completed in 1914. In that year the Land Drainage Act was passed, under which the Lower Ouse Drainage Board was set up. In due course, the Engineer to the Lower Ouse Drainage Board, Mr. A. H. Case, prepared a scheme for carrying out training walls in the Wash. This scheme was the subject of an Inquiry held by the Board of Agriculture and Fisheries at King's Lynn in 1918. There were 40 objections to the scheme. Four Corporations signified their approval. The outfall scheme was not recommended by Mr. Sidney Preston, C.I.E., who conducted the Inquiry.

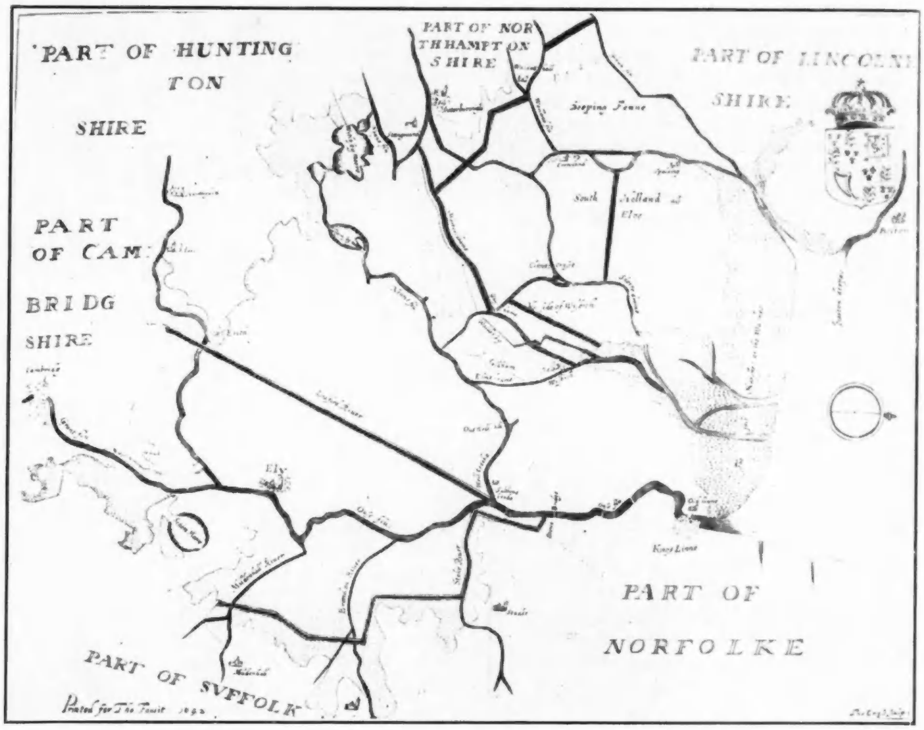


Fig. 3. Vermuyden's Plan 1642.

At this Inquiry a counter proposal was put forward by Messrs. D. & C. Stevenson and Mr. E. G. Crocker. This was for a barrage across the river at King's Lynn so that during a flood, the tide could be excluded and the flood water stored in the Tidal River during the period of tide lock.

Prior to the Land Drainage Act of 1930, under which Catchment Boards were set up, there was no river authority capable of undertaking such work and no means of financing it.

The Great Ouse Catchment Board came into existence in 1930 and inherited a sadly neglected river system. The South Level flood banks were in a dangerous state and the Board's first efforts were concentrated on the most urgent river improvements.

A Tidal Model was constructed in 1935 and investigations started on the "outfall problem."

A dangerous flood occurred in 1936, followed by a worse one in 1937.

As a result of these floods the "Association of Drainage Authorities within the South Level" asked Sir Alexander Gibb & Partners to make a report. The report, which appeared in January, 1939, recommended the installation of a large pumping station at Denver with a discharge channel, in which the water could be impounded during the period of tidal closure, entering the Tidal River at Magdalen Bend.

The River Great Ouse Catchment Board, faced with so many conflicting proposals, called in Sir Murdoch MacDonald & Partners to advise them.

Sir Murdoch MacDonald & Partners' report was issued in July, 1940.

It gave alternative solutions:—

(a) The construction of a Relief Channel of 175-ft. bed width from Denver to St. Germans, and a Cut-off Channel running from Denver round the edge of the fens to Grantchester, near Cambridge.

(b) The construction of the Relief Channel only if the Cut-off proposal was considered too expensive.

In both schemes allowance was made for the improvement of the banks of the Tidal River.

In December, 1940, Sir Alexander Gibb & Partners made a revised report recommending the installation of a pumping station at Earith to pump the water from the Southern end of the South Level system instead of from the Northern end, but retaining the Relief Channel from Denver to St. Germans.

The second proposal of Sir Murdoch MacDonald & Partners was ultimately adopted, but owing to the outbreak of war no immediate steps could be taken to put it into effect. It was decided nevertheless to go ahead with the designs and plans. Work continued on it during the war period and by the end of the war all the drawings and contract documents had been completed.

In the years immediately following the cessation of hostilities the shortage of materials, manpower, large contractors' plant, and the uncertainty of the financial situation prevented any start being made upon the scheme. There was, quite understandably, a reluctance on the part of the Catchment Board to embark upon so large a project at a cost so very much greater than had originally been contemplated.

Then came the record flood of 1947. Whereas in 1940 there had been a suggestion that Sir Murdoch MacDonald's scheme was too large, it was now found to be too small, a remark which applies equally to all the schemes which had preceded it.

The 1947 floods convinced all concerned that the Flood Protection Scheme should be carried out without further delay.

The scheme was modified to meet the new conditions. The new design provided for a flood of even greater dimensions than that of 1947 coinciding with a spring tide.

In the revised design, the Relief Channel was extended to the outskirts of King's Lynn, the Cut-off was reinstated up to the River Lark at Barton Mills in Suffolk, and the existing Ely Ouse was widened and deepened from Denver to the mouth of the River Cam.

At this point it will be convenient to give a brief explanation of how the scheme produces the results required.

It was pointed out previously that the obstacle to the discharge of the South Level waters through Denver Sluice is the high water levels outside the Sluice in times of flood.

The low water level at King's Lynn under high flood conditions is about 12-ft. lower than the level at Denver. By bringing the point of discharge to King's Lynn advantage can be taken of this lower water level.

The surface gradient in the Tidal River at low water under flood

The Great Ouse Flood Protection Scheme—continued

conditions is about 13-in. per mile. The Relief Channel is designed to carry the full flood discharge at a gradient of 3-in. per mile. With a low water level of 99.0 at King's Lynn we will get a level of 101.6 at the head of the channel at Denver[1].

As the tide rises, the outflow ceases and the gates of the Tail Sluice close. The water levels rise behind the gates until, as the tide falls, the gates open and the discharge is resumed.

Under design flood conditions the maximum ponding level reached is 6.5-ft. above Ordnance Datum, falling to 1.6-ft. at the Denver end at low water. Normal navigation level in the Ely Ouse is 4.5-ft. above Ordnance Datum, so the maximum level at Denver under design flood conditions is only 2-ft. above normal.

At Ely, 16 miles away, the level will be about 9.4. This is 2.5-ft. below the level reached in the much smaller flood of 1937.

It will be noted that while the Relief Channel discharges intermittently into the Tidal River at the Tail Sluice, the flow from the Ely Ouse into the Relief Channel is continuous.

The function of the Cut-Off Channel is, of course, to intercept the waters of the Wissey, Little Ouse and Lark and take them round the edge of the fens to the top of the Relief Channel at Denver.

By this arrangement 40 per cent. of the flood input is intercepted, the remaining 60 per cent. can be taken at safe levels in the widened Ely Ouse river.

The Relief Channel and Cut-Off are excavated in ground not subjected to wastage and the water levels are below ground level, so that the difficulty of sinking flood banks does not arise in their case.

The banks of the South Level will, of course, continue to sink, but at a rapidly diminishing rate. It will no longer be necessary to make them up continually.

In 1638 Vermuyden wrote " A Discourse Touching the Draining of the Great Fennes lying within the several Counties of Lincoln, Northampton, Huntingdon, Norfolke, Suffolke, Cambridge, and the Isle of Ely, &c.," for Charles I, in which he said:—

> "The three Rivers of Mildenhall, Brandon and Stoke, must bee made one river, and to that end Mildenhall must be brought into Brandon, and both into Stoke, and all into Ouse."

Does not this describe, in fact, what is now being done? His Discourse (published 1642) is accompanied by a plan, reproduced here (Fig. 3), in which is shown a Cut-Off Channel and a short Relief Channel. His Relief Channel was, in fact, made. It was 120-ft. wide and 10-ft. deep and entered the Tidal River below Stow Bridge 3¼ miles below Denver Sluice. The modern Relief Channel runs along its course.

[1] NOTE—Levels to River Board Datum which is —100 Ordnance Datum Newlyn.

The calculations and general drawings of the revised scheme were ready early in 1949, and it was decided that for a work of this character Parliamentary sanction would be necessary.

At the hearing before the Commons Committee, the Bill was opposed by six objectors The principal objection came from the King's Lynn Conservancy Board, representing the interests of navigation. They contended that the greatly increased flood discharge might erode the bed and banks of the river at King's Lynn and threaten the safety of quays and other riverside structures, and that quantities of silt would be carried out into the Wash and might obstruct the shipping channel. They demanded, amongst other things, that the Catchment Board (as it then was) should protect the banks of the channel from the end of the existing training walls out to Cork Hole, a distance of about six miles. After a hearing lasting from the 24th May to the 7th July, they were unsuccessful in gaining their point.

At the subsequent hearing before the Lords, however, their efforts were crowned with success and a very onerous clause for the protection of their interests was inserted in the Bill. In effect, this clause requires, amongst other provisions, that before the Relief Channel can be used for flood discharge purposes, protective works to be agreed between the parties must be carried out within the Port.

What an ironical situation! After ten years of work and delays, the Board, after having produced a scheme to deal effectively with the worst floods on record and having apparently freed itself from the shifting sands of the Wash, was confronted with the old training wall nightmare reappearing in new guise, not as a drainage scheme this time, but as a scheme for the protection of navigation. Would the sands of the Wash still have power to strangle the drainage of the fens?

The Great Ouse Flood Protection Act received Royal Assent in December, 1949, and from then until early in 1952 discussions continued between the King's Lynn Conservancy Board and the Catchment Board without agreement being reached. Eventually, however, a compromise was arrived at and an agreement as to the protective works was signed in August, 1953.

The way was now clear to commence the works.

The estimated cost of the scheme was £7½ million. It was decided to let the work in three separate parts:—

Part I The Relief Channel and Tidal River Banks.

Part II The widening and deepening of the Ten Mile and Ely Ouse.

Part III The Cut-Off Channel.

The contract for Part I was awarded to Sir Robert McAlpine & Sons Ltd., whose tender for the work was £2,919,426.

Work was commenced in July, 1954.

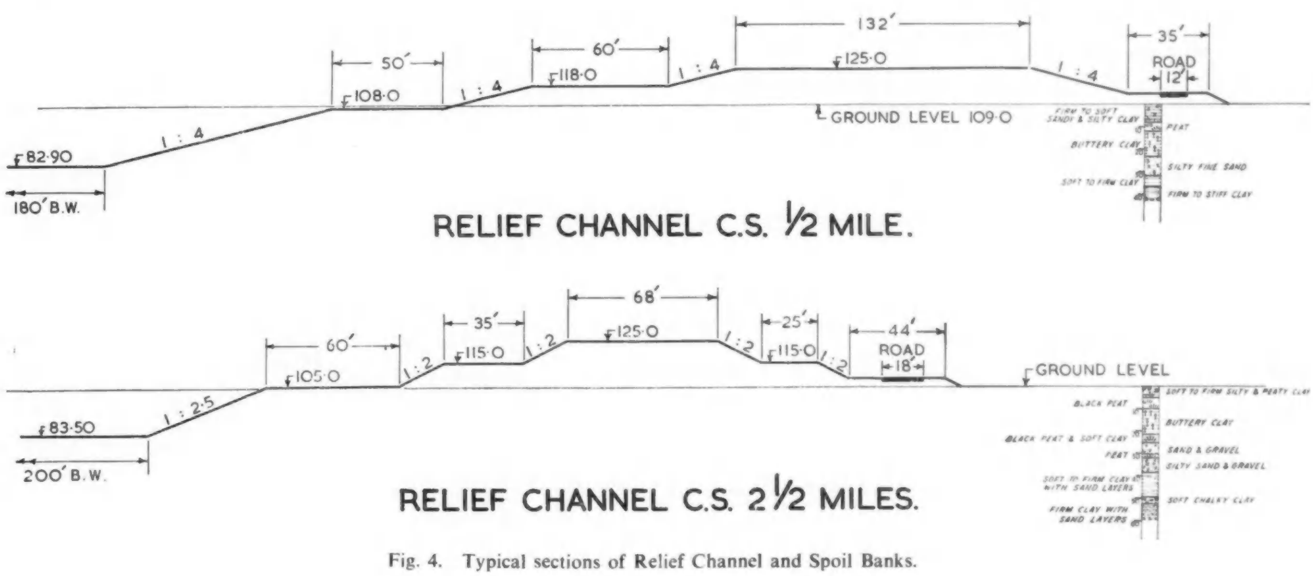
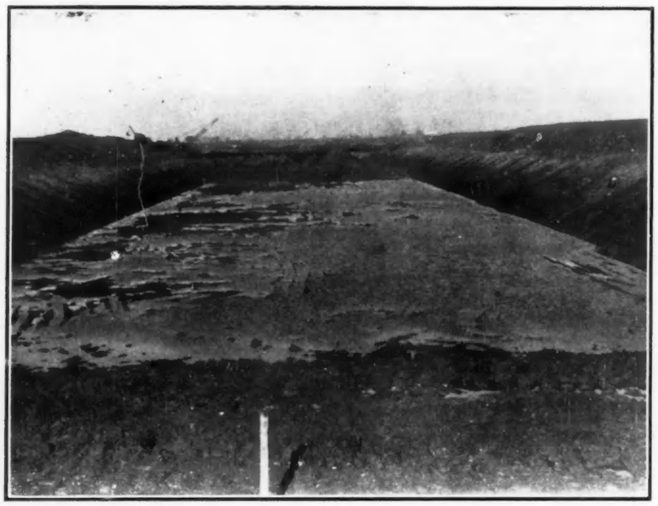


Fig. 4. Typical sections of Relief Channel and Spoil Banks.

The Great Ouse Flood Protection Scheme—continued



Relief Channel excavation.

1. THE RELIEF CHANNEL AND TIDAL RIVER BANKS

The Relief Channel from Denver Sluice to its termination in the Tidal River immediately South of the British Sugar Corporation's factory at King's Lynn is $10\frac{3}{4}$ miles long. For the first $5\frac{1}{2}$ miles the bed width is 175-ft., after which it is increased to 200-ft. The narrow bed width of the Southern part is imposed by the width available at some parts between the Ely-King's Lynn railway line and the Tidal River. When at maximum flood level, the depth of water at the Southern end will be 23.5-ft. and at the Tail Sluice 22-ft. The water level will at all times be below present ground level.

The amount of excavation will be over 12 million cubic yards.

There will be five new road bridges and one new railway bridge spanning the Channel; a sixth road bridge will be constructed across the Polver Drain.

The Channel cuts across the drainage system of the East of Ouse, Polver and Nar Internal Drainage Board and also affects the drainage system of the Stoke Ferry Drainage District, both of which drain into the Tidal River. This necessitates a somewhat complicated rearrangement of the drainage systems. This drainage reorganisation is being undertaken by the Great Ouse River Board.

At the Southern end of the Channel, a small flood reservoir or washland, 480 acres in extent, is provided, but this will only be required in extremely high floods. It will normally be used for purposes of agriculture.

The soil through which the Channel is to be excavated shows considerable variations. The most difficult soil conditions are encountered at the Northern end. Here the hard Kimmeridge clay lies at a depth of about 37-ft. below the land surface; overlying this is a very soft, silty clay (Buttery clay), which is up to 25-ft. thick; on top of the buttery clay lies a layer of peat, and over this, tidal silt.

Owing to the exceptionally low shear strength of the clay (about 230 lbs. per square foot), the designs both of the Channel itself and of the Tail Sluice have had to be completely modified.

Whereas further South the Channel can be excavated with side slopes of 1 in $2\frac{1}{2}$, it has been found necessary on the reach in question to flatten the slopes to 1 in 4 and to provide a berm 50-ft. wide between the edge of the Channel and the spoil heap. The spoil heap itself has a similar slope, with a berm at a height of 10-ft. (see Fig. 4).

It proved impossible to excavate down to the level required to construct the Tail Sluice and the construction of this has had to be modified as described later.

These very difficult conditions continue for about 1,000 yards, after which it is expected that more normal conditions will be met with.

The excavation of the channel on this reach is done by two $3\frac{1}{2}$ cubic yard Lima excavators with an outreach of 70-ft. These deliver the spoil to a 3-ft. 6-in. wide belt conveyor, which delivers it to another conveyor, or spreader, working at right angles to the main conveyor line, by which the spoil is deposited on the spoil heap. The main conveyor line has a hopper at the receiving end fitted with a mechanical arrangement for breaking up the clay lumps and feeding the spoil on to the conveyor. Owing to the nature of the clay and the variation in consistency of the spoil fed to the hopper by the excavators, much difficulty has been experienced in getting a regular feed to the conveyor belt.

A second set of excavators and conveyor have recently been put into operation.

Although the conveyor system has had its difficulties, it has the very great advantage of being largely independent of weather conditions. Moreover, there has been no difficulty in catering for the increased length over which the spoil has had to be transported on account of the flattening of the side slopes of the channel and the allowance of extra berm width. The present working distance of the conveyor is about 400-ft., which can be extended, if desired, to 1,200-ft. It is perhaps unnecessary to add that scrapers or Euclids could not work on the buttery clay even under the most favourable weather conditions.

The buttery clay is a sensitive clay and after it has been handled by the dragline bucket and has passed through the conveyor hopper it has somewhat the consistency of thick porridge. This embarrassing property of the clay has led to considerable difficulties in its disposal in the spoil heaps and additional land has had to be acquired to allow for this and the extra width of the channel excavation.

Further South on the Magdalen Bend cut and along the Channel in that reach, it has been possible to do most of the work with scrapers. Here the soil conditions are much better and South of Magdalen Bend the side slopes are 2 : 1. With the advent of wet weather, however, scraper work has to be stopped.

The work at Magdalen Bend itself is of some interest. Referring to the plan (Fig. 1) it will be seen that the Tidal River makes a big loop at this place. The Relief Channel passes across this loop and a new course, having a bed width of 150-ft., is provided for the Tidal River across the ends of the loop. Magdalen Bend cut was one of the first works to be started. Hard clay was encountered at a depth of 18-ft. below surface level. The cut was completed in July, 1955, except for the portions unexcavated at each end. When tidal water is eventually allowed to pass through, the banks will, of course, have to withstand high tidal levels. The specification therefore calls for the use of selected material compacted to 85 per cent. of maximum dry density. Fortunately there proved to be just enough good hard clay in the excavation to supply what was required for the banks. When the work was completed, it was tested by the controlled admission of tidal water. It is intended that the unexcavated portions at each end will be removed next Spring and the river passed through the cut. The old loop, except where the

Conveyor delivering spoil to spoil bank.

The Great Ouse Flood Protection Scheme—continued

Relief Channel passes through it, will then be filled in with spoil set aside for the purpose.

One clay slip occurred during the making of the cut. This was made up with good material and no further trouble has occurred.

At each end of the cut the banks are protected with mattress work and slag pitching. Much use has been made of this system of protection, which will be described later.

Tidal River Banks.

From Free Bridge at King's Lynn to a short distance below St. Germans Bridge, the river runs in a straight cut known as the Eau Brink Cut made by Rennie in 1817-1821. From the end of the Eau Brink Cut to Denver, a distance of 9¾ miles, the river follows its somewhat tortuous natural course.

The tops of the river banks stand 12 to 15-ft. above the level of the land behind them. On the river face of the flood banks there may be a berm of varying width, but on the concave side of bends, little or no berm is present.

The banks and the berms consist of fine tidal silt. Due to the combined effects of silt accumulating on the berms and erosion on the toes of the slopes, slips are constantly occurring. The traditional method of rectifying these slips is by faggoting. The River Board use some 200,000 faggots annually on this work.

In addition to being very unstable on the front, the banks are deficient in height and section and the back slopes are too steep.

During the tidal surge of 31st January, 1953, the tidal river banks were overtopped for many miles and were breached in 13 places. 6,266 acres were flooded by tidal water.

Provision has been made in the Flood Protection Scheme for making up the banks to a satisfactory section with good spoil taken from the Relief Channel excavation. Along many stretches the right bank is being set back to allow an adequate width of channel and to ease bad bends.

The new bank top level will provide a freeboard of 3-ft. above 1953 surge level. The bank top width will be 12-ft. and the back slope 3 : 1.

Where the existence of houses does not permit the desired section to be obtained, concrete surge walls are to be constructed.

Bank Revetment

A feature of special interest is the extensive use made of willow and brushwood mattresses and slag pitching for bank protection in the Tidal River. This system was first used on the river in 1936-39, when the river banks from Free Bridge to the training walls were protected in this way. The work was done by The Dredging and Construction Company Ltd., and has required no maintenance, except repairs to occasional damage from vessels, since it was done. The same Company are carrying out the present work as sub-contractors to Sir Robert McAlpine & Sons Ltd.

Tidal River, Magdalen Bend Diversion.

Slag pitching and completed bank on the Tidal River.

Willow and brushwood mattresses are, of course, a traditional method of underwater protection in Holland, where they have been used for centuries. As they are not widely known in this country, a brief description of their construction and use may be of interest.

The mattresses are made on a prepared launching site which slopes gently towards the river. The first process is to make the "wieps" which, although not made by twisting, might best be described as cables about 15-in. in circumference made of two year old willows bound at 20-in. intervals with one year old willow ties.

The wieps are laid on the launching site to form a grid of 3-ft. squares and are bound together at the intersections. Next comes a layer of reeds and on top of this two layers of brushwood, one laid longitudinally and the other transversely. These make up a thickness of about a foot. On top of the brushwood a top grid of wieps is constructed to correspond with the bottom one. The two grids are now pulled tightly together by means of the ropes binding the intersections. Stakes are now driven in along the two or three outside rows of wieps and osiers are woven on them to form "hurdles" to retain any stone which might tend to roll off the mattress when it is sunk. Towing bollards, also formed of stakes, are placed as required and the mattress is ready for launching when the tide reaches the launching site. Such mattresses may be twelve or more yards in width and twenty or thirty yards long. The larger sizes are, of course, more difficult to handle and sink than the smaller ones.

If, for example, the mattress is to be used to revet the underwater slope of a bank, it will be towed into position and secured by moorings along the bank. Stone barges are then brought up and the mattress is sunk by throwing "man size" lumps on to the mattress in such order that it sinks evenly into position. Skill and experience are necessary to sink a mattress properly. After it has sunk, further stone is thrown on to weight it down—usually about ¼ ton of stone per square yard is used in all.

In a silt charged river such as the Ouse, the mattress quickly traps the silt and becomes a silt and stone revetment.

This system has the great merit of durability and flexibility. It will accommodate itself to local irregularities and if, after it is laid, scour commences along the outer edge so as to undermine it, it will bend over and limit the progress of the scour. Mattress protection is used from bed level up to low water level. Above low water level, protection is given by slag pitching. This consists of lump slag set in a bed of smaller broken slag, which in turn rests on a bed of reeds. The large lumps are keyed together with spalls. The total thickness of the finished work is about 18-in.

It will be noted that no grouting is used. It is important that the water should be free to drain away, otherwise a hydrostatic pressure would be built up; moreover, ungrouted pitching remains

The Great Ouse Flood Protection Scheme—continued

Preparing to sink a mattress on the Tidal River.

flexible and can accommodate itself to settlement, if any, in the bank.

A total of 118,000 square yards of pitching and 86,000 square yards of mattress work is included in the contract. This includes the revetment of the left bank of the river from the Tail Sluice exit channel to Freebridge, similar work for a distance of 100 yards on each side of the four bridges across the Tidal River, protection at either end of the Magdalen Bend and from the Northern end of the Bend to Magdalen Railway Bridge, etc.

It would probably have been impossible to obtain the large supplies of willow and brushwood needed for the work but for the fact that the River Board has its own willow holts for the purpose and had also made arrangements for the cutting and supply of brushwood from various estates in Norfolk.

The value of the supplies of willow and brushwood in the Board's depot at King's Lynn recently was over £23,000.

Structural Works

Structural works include the sluices at the head and tail of the new Channel, five road bridges across the Channel and one road bridge across the Polver Drain, a railway bridge, protective piling for Free Bridge at King's Lynn and also at the entrance to King's Lynn Docks. *(To be continued)*

Book Reviews

Hydrographic Surveying for Development and Conservancy. By Lieut.-Cmdr. A. D. Margrett, R.D., R.N.R., F.R.G.S. 67 pp. with diagrams.

Surveys for engineering projects and small harbours are now in increasing demand, and it is important that they should be undertaken with fuller nautical knowledge and equipment than was common in the earlier part of the century.

The hydrographic surveyor combines his nautical knowledge and experience with sound land surveying qualifications, and if, in addition, he has an appreciation of the problems of the civil engineer his work will be considerably enhanced in value.

A great deal of the older work was done by wire measurement, often related only to the topography of the areas under consideration, but modern survey data, and the increased precision of instruments available, demand as a necessary basis for all modern work, a soundly triangulated set of land control stations from which well-conditioned sounding marks are derived.

In addition, the newer technique of echo sounding does not limit the speed of the survey craft, and thus demands the double simultaneous sextant-angle procedure afloat, and the use of the three-point fix by every expedient that can simplify and speed up the work.

The book by Lieut.-Cmdr. A. D. Margrett provides a sound compendium of fundamentals, which should be known by all engaged in this sort of work.

It includes elementary triangulation, essential levelling, traversing, and elementary plane-table work. In addition, a chapter on the orienting of surveys by astronomical azimuths is given, and should be studied by those preparing plans ultimately for consideration by seamen and hydrographers. It is of the greatest importance that this should be done in new surveys of coastal and harbour areas. Methods for determining the local magnetic variation are not described, but would have been a useful addition.

The work could, perhaps, have been improved by including the method of astronomical time azimuths, as it is now fairly simple to obtain correct astronomical time by radio in most part of the world, and the calculations are much simplified thereby.

A reference to the levelling of offshore tide gauges involving corrections for curvature and refraction would also have been helpful to many.

The reference to the fine-wire bottom sweep is useful, and should be more widely known to surveyors, but it is also important that something should be said in a future edition about determining the nature of the bottom by deeper penetration for undisturbed samples down to, say, 6-ft., and a description of the devices by which this can be done, to assist modern engineering prospecting.

Also, despite modern developments, the use of the lead and line for investigating irregularities in contours should not be forgotten, as this ancient method is frequently of great value in checking the existence of hard objects level with the bottom, such as rock outcrops, which are not often discernible on the echo-sounding trace.

The reference to subtense distance for close offshore work is valuable, and the method should be more widely known.

The propagation of bar-check techniques for calibrating echo-sounding records cannot be overdone, and is adequately dealt with.

Altogether the book is valuable as a concise compendium of some essential fundamentals which should certainly be appreciated and known by surveyors, civil engineers and seamen interested in conservancy, who are commencing the study of these problems.

D. H. M.

"Handbook for Harbour Construction and Port Working." (Handmuch für Hafenbau und Umschlagstechnik"). Volume II, 320 pp. Published by Schiffahrts-Verlag "Hansa," C. Schroedter & Co. Hamburg.

This work is the second volume of selected technical articles dealing with ports and portworking which have appeared in the well known German technical publication "Hansa" during the years 1953-1954. It is published under the auspices of the Hafenbautechnischen Gesellschaft (Association of Port Engineers). The book is well printed and illustrated, the text being grouped under six headings:—

I. Reports on the work of the Association.
II. Sea and Inland Waterways.
III. Sea Shipping and Sea Ports.
IV. Inland Shipping and Inland Ports.
V. New Construction in Sea Ports.
VI. Port Equipment and Cargo Handling.

The foreword to the volume and the introductory article is contributed by the well-known Professor Dr. Agatz, Bremen.

In all there are 80 articles subscribed by 53 well known experts, almost all of proven practical executive and administrative skill, names of imposing worth in German maritime circles such as Drs. Agatz, Bolle, Förster, Hensen, Mühlradt, Neumann, Walther, and Wundram. The great feature about this large volume is that there is little repetition and all articles are carried to a logical conclusion by meticulous argument.

It is interesting to note that "The Dock and Harbour Authority" was represented by several articles, which were first published in that Journal and subsequently translated into German.

R. R. M.

Cargo Handling in the Philippines

Review of New Methods Developed

However enterprising port officials may be, the speed and manner in which they can introduce new goods handling methods is to some degree controlled by local conditions. The " geography " of the port, the climate, the type of traffic, the availability of power, the aptitude of the workpeople, local customs, practices, traditions and even religions are all factors affecting port operating work—and progress in handling methods is often made despite the existence of these factors. Thus, steps taken to improve handling facilities and methods in any particular port are always of interest in shipping circles.

There is up-to-date information on cargo handling methods in the ports of the Philippine Islands in the United Nations' Transport Bulletin (Asia and the Far East Section) of October, 1955. An article on " Current inland waterway developments " commences with the note " there are hardly any real inland waterways in the Philippines but coastal shipping on the intra-island routes plays a very important part in the economy of the country. The following gives an account of recent developments in connection with this type of transport ".

The article has two main sections, (1) New methods developed in the loading and unloading of cargo and (2) Improvement in ships' cargo-handling facilities.

" General cargo ", it is stated under the first heading " is handled chiefly by means of ship's gear or by the ship's gear in conjunction with cargo masts and winches on the dock. In this type of operation, the speed of loading and discharging and the adequacy of the stowage are largely dependent upon the skill and experience of the stevedores, the steamship company's dock force and the ship's officers.

Much of the general cargo, such as packages, is transferred from the pier to the ship either by way of the ship's hatches, or by way of side ports.

Handling Methods Employed on the Ship

The article goes on to state that the methods employed in loading and unloading through hatches include :—

(*a*) **" The whip (or single-fall) and skid system.** The simplest method of using ship's gear for loading cargo is to employ one winch and one boom with its attendant fall, together with an inclined skid leading from the pier to the deck of the ship. The boom is placed so that its peak or outer end is directly over the hatch opening. When the cargo draft or sling load is made ready on the pier it is brought to the foot of the skid, and the hook on the end of the fall is hooked onto the draft. The winch is then started and the draft is dragged up the inclined slod and over the bulwarks. It then swings over to the hatch by its own weight. The winch is reversed and lowers it into the hold. To prevent the draft from swinging from side to side a worker on the deck of the ship steadies it by means of a rope attached to the hook, or by a guide line thrown around the fall just above the hook. When the draft is landed in the lower hold or between decks the hook is released ; the deck man pulls it up by means of the guide rope, and throws it back to the pier for the next draft. With seasoned workers, considerable speed can be attained in loading cargo by this method, which is called at some ports the " whip and skid ", and at others the " single-fall and skid " system. It is only suitable for loading, and is likely to damage many classes of cargo ".

(*b*) **" The double whip or split-fall system.** A somewhat faster way of working cargo is provided by the " double-whip " or " split-fall " system. Two booms and two winches are employed, one boom extending over the hatch opening, the other over the apron of the pier. In loading, the draft is lifted from the pier to the deck of the ship by the boom and fall extending over the pier. As soon as the draft is landed on the deck the hook is released and thrown back on the pier. The hook attached to the other fall is then hooked onto the draft, which is lifted clear of the deck, swung over the hatch opening, and then lowered into the hold. In discharging the movements are reversed. This system is widely used for the handling of bagged cargo, also for copper ingots, pigs, etc., and many steamship companies have found it the most rapid and satisfactory method of working miscellaneous general cargo. This system will handle five sling loads of cargo in the same length of time that three sling loads can be handled by the " married-fall " system ".

(*c*) **" The Burton System.** In the so-called " burton system ", the " burton man " (as the deck man is usually called) throws the hook of the second fall (attached to the boom over the hatch opening) around the first fall (attached to the boom extending over the pier), and thus unites the two falls while the draft is being lifted from the pier. The fall serving the pier is called the burton fall. The draft is raised above the bulwarks and is moved athwartship and down through the hatch opening by the joint action of the two winches. Just before the draft is about to be lowered through the hatch, however, the burton man releases the hook of the pier fall and throws it back to the pier for another load. In discharging, the movements are reversed."

(*d*) **" The union or married-fall system.** The union or married-fall system is the one most commonly employed for both loading and unloading cargo with the ship's gear. It is sometimes called the " yard-and-stay " system, and in England is referred to as the " union-purchase " system. It is also referred to as " burtoning ". The cargo booms and two winches are employed. One boom extends over the hatch opening, and the other is swung out so that its peak is over the apron or edge of the pier. The ends of the two falls are brought together and terminate in a single-hook. In loading cargo, the fall operating from the boom over the ship's side lifts the draft to a point above the ship's bulwarks. The fall on the boom over the hatch is then taken up on its winch, while, at the same time, the other fall is slacked away. This joint operation brings the draft over to a point above the hatch opening. Both winches are then reversed and the draft is lowered into the hold. When discharging cargo, the movements are reversed ".

(*e*) **" Ship's deck cranes.** Some ships, though relatively few in number, are provided with power-driven revolving cranes that are installed on deck between the hatch opening and the bulwarks, usually near the corners of the hatch openings. In certain cases, such cranes are useful adjuncts to the ordinary ship's gear, but they are somewhat expensive to install and occupy a certain amount of useful deck space. Generally, they are fitted on more or less specialized ships, such as coasting vessels that are fitted with hatches and other ships that make short-distance voyages. Frequently, they serve only one or two hatches such as those closest to the amidships superstructure, while the ship's booms and winches handle cargo from the other hatches. A type of deck crane in common use is one that has a 2-ton lifting capacity and a radius of about 6.1m (20 ft.)".

(*f*) **" Ship's gear in conjunction with cargo masts and winches. on the pier.** A number of piers are provided with cargo masts or cargo beams to facilitate the loading and unloading of freight. These are usually strong metal masts, erected near the edge of the pier or against the outer face of the pier shed, and connected with one another near their peaks by means of steel beams or girders. The tops of the masts are generally about 18 to 24 m (60 to 80 ft.) above the mean low-water level. A catwalk runs along the entire length of the structure close to the beams. From this catwalk, workers can shackle stirrups to which blocks are attached in holes that are conveniently spaced at 60 or 90 cm (2 or 3 ft.) intervals in the beams.

A fall or whip passes through each block. One end of the fall leads downward to an electric winch on the pier. The other end of the fall is usually " married " or joined to the end of a fall operated by one of the ship's booms and winches. Thus, drafts are loaded or discharged by the joint operation of the pier winch and one of the ships' winches. There are three movements, which are the same as those involved when the union or married-fall system is employed, using two ship's booms and two ship's winches. When loading, the draft is lifted from the dock by the pier winch. The ship's winch then moves the draft inboard, while the pier winch at the same time slacks away. The draft is then lowered through the hatch opening by the ship's winch, operating in reverse, the pier winch slacking away simultaneously. In discharging, the movements are reversed ".

Cargo Handling in the Philippines—continued

Slinging Equipment

In connection with slinging equipment, descriptions are given of two conventional types of rope, wire and chain slings and cargo nets and trays. Specially designed slings are also used and the article devotes much space to describing them.

" The results obtained by developing and applying suitable specially designed slings for loading and discharging foreign-trade vessels are worthy of note. During a period of about 5 years, nearly 20 pieces of equipment, all simple in construction, were developed and put into use. The employment of these aids to cargo-handling reduced claims for damage to import and export freight by more than 75 per cent., and reduced time of loading and unloading by nearly 50 per cent.

Prior to the introduction of this new equipment, rope slings were used for the loading and unloading operations. This method resulted in considerable damage to all soft-packages shipments, such as flour, sugar, soda, coffee, and other commodities packed in bags. Unavoidable slipping of the sling also frequently released barrels, boxes, and other hard packages, allowing them to fall to the apron of the dock or the deck of the ship. Pipes, sheet and structural steel, glass, and similar products were also injured by the slings and, even when successfully handled, worked a hardship on the stevedores, both on the dock and in the holds.

One of the greatest losses in time and money resulted from the handling of bagged cargo in rope slings. To overcome this, a platform sling was developed, which consisted of three long planks and two short transverse ones. This platform is fitted either with metal eyes to engage four hooks attached to the lifting tackle or with two permanently attached bridles. The platform is 1.52m (5 ft.) long and 0.86 (2ft. 10in.) wide. Moveable spreaders made of narrow board are placed on the slings at each end to keep the ropes apart and thus lessen twisting as well as reduce pressure on the load.

With this platform the weight is well distributed over the lower layer of bags, instead of being forced down on the bottom one or two bags, as when a rope sling is used. The platforms are placed on platform trucks, rolled to the stack in the warehouse or on the dock, the bags piled, and the truck sent to shipside, where the lifting tackle picks up the sling and moves it inboard at about twice the speed possible when handling a simple rope sling. Sugar, coffee, soda ash, salt, beans, potatoes—in short, practically all bagged cargo—is loaded and unloaded with these platforms, which are also used for plate glass in small sizes, and other commodities. It is stated that damage to bagged cargo has been reduced by about 40 per cent., and the quantity lifted at each movement increased by approximately 30 per cent.

If the sacks are larger than usual, or the commodity much heavier than usual, " wide-board " slings are used. These are platforms made of three wooden strips, each 2.1m (7 ft.) long, 10 cm (4 in.) wide, and 5 cm (2 in.) thick, with similar strips 90 cm (3 ft.) long, bolted across at each end and in the middle. With these, 2.7 cm (9ft.) wire bridles are used, which carry wooden spreaders 90 cm. (3 ft.) long, that is, with a length equal to width of the platform. In addition to bagged cargo, these slings have been found of value in handling canned goods and other case goods.

These slings not only are easier and faster to load in the warehouse or on the dock, but they can be handled more rapidly by the ship's gear because there is little danger of slipping, and twisting is largely eliminated. Also they are more easily and more rapidly unloaded when they reach the floor of the hold. There they can be either dropped flat on the floor or set on dollies to be run to any part of the hold for stowing.

For the handling of cement and wet salt, boards 1.4m (4.5 ft.) long 55 cm (1ft. 10in.) wide, and 5 cm (2 in.) thick, with 5 cm (2 in.) cleats the full width of the underside at each end, are used. These have 1.5m (5ft.) wire-rope bridles, brought together so that the ship's hook engages a loop in each at the top. In these platforms the floor boards are placed close together, and they are handled on small four-wheeled platform trucks, which can be drawn by one man or pulled in a chain by a tractor.

Another solid-board platform is the so-called " soda-ash " sling, 1.6m (5ft. 4.25in.) long, 75 cm (2ft. 5in.)wide, and equipped with equal-length wire-rope bridles, 1.8 m. (6ft.) long, anchored into the four corners and meeting in two loops at the top, so the ship's hook can engage them easily. Heavy loss was sustained annually by the breakage under the old method of using rope slings. Moreover, the ash, falling on the steel sides and deck of the ship, injured the metal as soon as it became wet.

One of the larger platform slings of the airplane type used in the handling of general cargo, and especially of large packages, furniture, stoves, and similar commodities, consists of a platform made of five longitudinal strips, each 1.9 m (6 ft. 5in.) long, 10 cm. (4 in.) wide, and 5 cm (2 in.) thick. Around this platform runs a rim, 7.5 cm (3 in.) high and 5 cm (2 in.) thick, held in place with iron clamps placed at frequent intervals. Wire-rope bridles, 2.4 m (8 ft.) long, are attached to the sides, about 38 cm (15 in.) from each end. These platforms are carried on large, flat hand-trucks or dollies, especially devised for their transportation, and move approximately twice the amount of general cargo that can be handled in the same length of time when rope slings are used.

Larger, and also smaller, sizes of this type of platform were built but experience showed that the particular dimensions cited were best adapted to the widest variety of cargo.

Short lengths of structural steel, short pipes, water-heater tanks, and similar commodities also can be handled on this sling, as well as packaged goods of all kinds, owing to the placing of the bridle-ends well back from the ends of the platform. Barrels that bulge at the middle, such as those used for molasses, wine, sugar, or barrelled china and glass-ware, are placed, three at a time, on one of these platforms and transferred to the hold or between decks. With a rope sling or cant hooks, only one or two barrels could be handled at a time. Obviously, whenever one operation transfers three times as much cargo as was previously possible, time of loading and unloading may be materially reduced.

For metal drums, such as those commonly used for petrol, kerosene, oils, and paints, another special platform sling has been devised. This consists of a solid platform 2.1m long, 45 cm wide and 15 cm thick (7 ft. x 1.5 ft. x 6in.), with three cross-cleats, 15 cm wide and 5 cm. thick (6 x 2in.), on the bottom. This carries 2.4 m. (8ft.) wire-rope bridles. On the platform, cylindrical drums, that do not bulge at the centre, can be laid on their sides, one deep, as many as will fit the length of the sling, which is usually four. These drums were formerly handled one at a time, or at most, two at a time.

The handling of iron and steel products, particularly large pieces of sheet iron, always has been a problem to the ship operator. A new method was developed that has proved very satisfactory. For large and thick sheets " alligator tongs " are used, with the addition of an ice-tong principle, which makes it possible for one man to apply the tongs in such a manner that the sheet can be lifted from a flat position on a pile, either onto the dock or into the ship's hold.

For smaller and narrower pieces of steel and iron, " side dogs " with rings through which a moving chain passes are used, the whole being hooked to the ship's tackle.

For still smaller pieces, for structural steel of short lengths, and for other similarly heavy and hard commodities, two special platform slings were devised. The larger of these, known as the " sheet-iron board ", is 2.9 m long by 1.2 m wide (9.5 ft. x 4 ft.), and is made of three longitudinal strips, each 15 cm wide by 5 cm thick (6 in. x 2 in.), fastened together by four cleats, each 10 cm wide and 5 cm thick (4 in. x 2in.) Two of these cleats are bolted on, transversely, at each end. The other two are set in the same manner about 30 cm (1ft.) from each end. Rings at the ends of these inner transverse bars engage 3 m (10 ft.) wire-rope bridles. Sheet iron up to 1 m (3.5 ft.) in width can be handled easily and quickly on this type of sling, a number of sheets at a time, whereas only one at a time can be picked up by alligator tongs.

A narrow " sheet-iron board ", built the same way, but 3.6 m long by 0.6 m wide (12 ft. x 2 ft.) also is used for small strips of sheet iron, short lengths of structural steel, reinforcing steel, pipe, tubing, and similar metal equipments.

For large and bulky packages of light weight, such as cotton waste, sacked and baled paper, empty cartons, and so on, another large board is used, somewhat of the same design as the large sheet-iron board. It is 2.7 m by 1.2 m (9 ft. x 4 ft.), with 3 m (10ft.) wire-rope bridles, held apart by 1.2 m (4ft.) spreaders. Ten large bales of cotton waste can be handled at a time, as compared with two, or at most three, with a rope sling. Baled cotton is also loaded and discharged with this device, three to four bales being handled at a time, as compared with one when a rope or canvas sling is used.

Cargo Handling in the Philippines—continued

For iron pipe in long lengths, the narrow sheet-iron board, 3.6 m by 0.6 m (12 ft. x 2ft.), is used as a sling. As a complement to the sling, a special pipe truck, with a flat bed, operated by one man or by a tractor, is employed. This truck has a bed 2.3 m long by 1.3 m wide (7.5 ft. x 4ft. 2in.) made of 20 x 20 cm (8 x 8 in.) timbers, with chocks and movable iron pins at each corner, to prevent the pipe from rolling off. The truck also can be used for handling water-heater tanks, small boilers, large tubing, and other materials of this class. The truck has four wheels, the forward pair turning beneath the body, so that the vehicle can be turned in its own length. Pipes can be laid on the narrow sheet-iron board placed on the top of this truck, or can be picked up with a chain sling with two loops, according to the operator's preference. The board, however, has several advantages, including elimination of much of the twist and sway, and possibility of making a better landing in the hold.

A newsprint sling has been developed which lifts the large and heavy rolls of paper evenly off the warehouse or dock floor or the truck or car platform, without damaging the edges, and sets them down in the same manner. Two rolls are handled at a time, with a loop around each, the lifting line running up between the two, so that the weight is distributed evenly. Prior to the introduction of this simple device, much damage was caused by the pick-up of newsprint rolls from one edge. Similar slings have been devised for handling large objects, such as transformers, weighing 6 or 7 tons, cement mixers, and other portable machinery weighing from 10 to 17 tons. Unboxed automobiles are handled to-day at many piers by means of two strong rope nets, each about 1.8 m long and 0.76 wide (6ft. x 30 in.)). One net is passed underneath the automobile at a point just behind the front wheels, and the other net is passed underneath at a point just forward of the rear wheels. Wooden spreaders keep the nets from closing in against the automobile while it is being lifted.

A special wire-rope sling is also used at some piers. This sling ends in four large, flat hooks, the inner surfaces of which are curved to engage the curved inner surface on the automobile wheel. These hooks are slung under each wheel of the vehicle, and the car is lifted to its place on the deck or in the hold. Each sling has a set of hooks for the different sizes and weights of motor-cars and trucks, as well as a heavier set for tractors. For trucks, the sling may consist of 4.9 m (16 ft.) wire bridles, with flat hooks and 2.1 m (7 ft.) wood spreaders. Similar bridles, with longer spreaders, are used for handling passenger cars, so as to avoid scratching. No spreaders are used on the tractor slings, which, as a rule, are hooked under the axles ".

Working through Side Ports

In dealing with loading and unloading through side ports, the article states:

" Most **coastwise** cargo steamers in the Philippines are loaded and discharged through side ports, and this is also the common method employed on the Great Lakes, U.S.A., " package freighters " that carry cargoes of miscellaneous packaged merchandise. Furthermore, there are some ocean-going vessels, particularly of the intermediate passenger-and-cargo-carrying type, that are fitted with side ports through which a portion of their cargo is commonly loaded and discharged.

Hand trucks, fork trucks, tractors and trailers, lift trucks carrying skids, and portable conveyors are all used for side-port loading and unloading. In handling freight by hand-truck, a gang-way is laid between the pier and the side port. At some ports there is often a considerable difference in level between the pier and the entrance of the side port, owing to variations in height of piers and side ports, in tide level, and in draught of the vessel, and this difference may become so great that it will be impossible for the longshoremen to push their trucks up the gradient.

At some coastwise piers, fork trucks, working in the ship, are operated in conjunction with tractors and trailers. This system is sometimes used for handling goods that are carried in the ships on loaded pallets. At the port of discharge, a fork truck working in the ship exclusively, picks up the pallet loads and puts them on trailers. When several trailers are loaded, they are made up into a train and drawn through a side port to the pier by means of a tractor. On the pier, the loaded pallets are removed from the trailers by fork trucks which stack or tier them two or even three pallet-loads high ".

Under its second main heading *via*: " Improvements in ships' cargo handling facilities," the article points out that " Very important advances have been made in recent years in the construction of ships and in the character of their cargo-handling facilities to promote speedier loading and discharging and reduce the ship's time in port. These improvements include the enlargement and widening of hatches, the lengthening of cargo booms, increased power and speed of winches, and removal of obstructions from, and enlargement of, holds. Continued study is being given to these matters by shipping men and their technical advisers ".

Supplementary Appliances

Supplementary appliances which in many instances proved very useful and effective in the Philippines in loading and unloading uniformly packed general cargo, both through hatches and side ports include conveyors. " It may be said that all conveyor-types of transfer, have the advantages of direct-line motion, as compared with the arc of a revolving crane boom, and usually provide for more continuous motion than the use of ship's gear. It must not be overlooked, however, in connexion with all devices for rapidly loading ships, that the speed of transfer is limited by the ability of the workers in the hold to stow the goods. In discharging, the speed is limited by the ability of those in the hold to break out the cargo and feed it to the conveyors. Furthermore, in discharging, the speed with which cargo can be removed from the conveyor is of importance in determining the speed of the total discharging operation.

The use of conveyors has been found by experience to be particularly adapted to certain established trades in which the average size of packages and other factors favour this method of handling. Thus, in the North Atlantic trade it has been found that approximately three-fifths of the average cargo from the United States to the United Kingdom can be handled from ship to quay-shed by conveyors. This method has the advantage of good speed and it also avoids exposure to the weather on the quay, as would be the case if the goods were deposited on the quay by the ship's gear. Sorting is done inside the quay-shed, as time permits, and without delaying the discharge of the ship.

At a certain United States port, canned goods are loaded through a side port with a portable belt conveyor at a rate 10 per cent. faster than for an adjoining gang loading the same commodity with the ship's gear.

Several types of vertical-belt or elevator conveyors have been developed to carry goods vertically up from or down into a ship's hold. The goods to be handled must be more or less uniform in size and weight for successful operation, and sufficient space is required in the hold to serve the boot or lower end of the conveyor.

This type of equipment is used in the United States chiefly for unloading bananas, and has been installed for this purpose at such ports as New Orleans, Galveston, and Los Angeles.

Some of the statements made in the cargo-handling section of the article are inevitably controversial. One of these (not already quoted) is that " in many European and other ports the use of quay cranes is predominant. This is so chiefly because the warehouses at these ports, used for the same purpose as pier-sheds in the United States, are usually placed at a considerable distance from the quayside and are separated from the quayside by several lines of railway trucks. Cranes can swing cargo over the space between quayside and warehouse, whereas ship's gear cannot ".

The last statement in the foregoing paragraph is, of course, true, but the main reason for the installation of quay cranes is a different one. The quay crane is faster for quite a lot of work than ship's gear or ship's gear and house-falls. One important reason why this is so is that it can, if properly placed, plumb any part of the square of the hatch, either end of a barge, any section of a land vehicle and also a large area of the quay. Moreover, it can be used to supplement ship's gear. Shipowners are concerned with the speed of turnround of the ship and not the outputs of individual gangs. Two gangs in a hold, one using a crane and the other a ship's derrick, can often discharge cargo at, say, $1\frac{3}{4}$ times the speed of one gang.

There are also two points of view about the employment of special loading platforms for certain goods. Metal drums, for example, can

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Mobile Offshore Platform

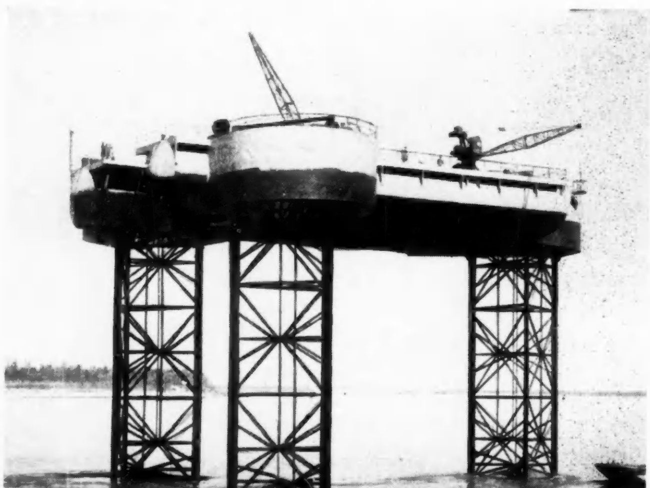
Self-Elevating Installation for Marine Work

R. G. LeTourneau, Inc. of Longview, Texas have recently completed a novel three-legged marine platform for the Zapata Offshore Company of Houston. Floated four hundred miles down the Mississippi to its purchasers in the Gulf of Mexico, the platform is now being fitted out for use as a portable oil-drilling platform. Such a device, however, can be used for a number of purposes, ranging from mobile radar stations to portable docks. A brief description of the initial platform will therefore be of interest.

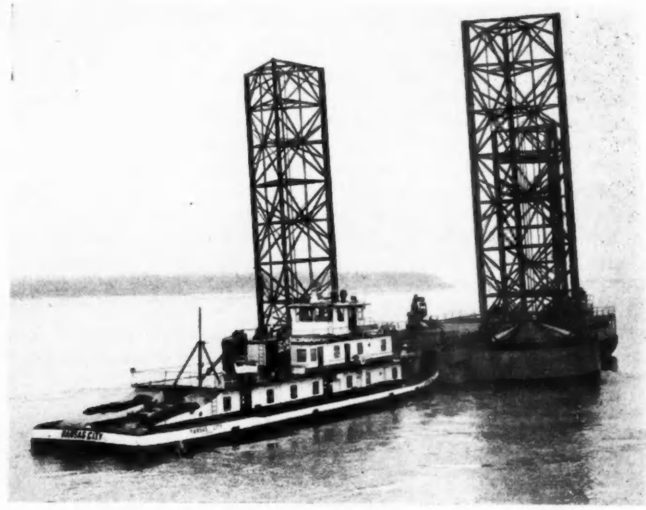
This installation consists of a floating barge 150-ft. long by 80-ft. wide, equipped with three electro-mechanically powered spuds or legs. The legs can be lowered to ocean bottom and the platform self-elevated on the legs to the desired height above water. The complete length and width of the platform, including the spud housing is 185-ft. by 150-ft.

The barge structure is of tubular and corrugated design to provide maximum structural strength and stability with minimum weight and internal bracing. Three large tubes, one on the starboard, one on the port and one on the aft end form the basic hull structure. These are joined by the centre section which has a corrugated bottom design. The tubes and the centre section are divided into compartments by bulkheads, decks, and watertight doors. Platform construction is of all-welded steel.

The legs operate in spud wells which are placed outboard on the two sides and the aft end. Power for elevating and lowering the legs and platform is supplied by LeTourneau Electric Gear-



Testing the legs in the River Mississippi.



The Unit being towed down river to the Gulf of Mexico.

motors which are mounted in the spud wells. The final drive pinions of these units mesh with the gear racks on the triangular-shaped legs. All the motors have integral motor-load brakes that set mechanically when electric power is cut off and are released when power is applied. These gearmotors are easily accessible through watertight hatches on the deck.

The open-design, truss-braced legs are of all-welded steel construction. A pontoon tank form the lower end of each leg. Gear racks on the legs extend on to the pontoons to permit raising them into the spud wells during towing.

Electrical power for operating the legs and elevating and lowering the platform is supplied by four diesel LeTourneau A.C. Generators located in the starboard tube of the barge structure. These units also furnish electrical power for operating the two 250-ft. ton revolving cranes and the three electric winches mounted on the platform deck. Spud operation and platform elevation is controlled from the operator's control room on the deck.

It is to be noted that the three legs are so positioned that they are able to afford stable and level support regardless of ocean floor level variations. Each of these legs can be operated independently and their open design, truss braced for stress loads afford the minimum resistance to wave action. The platform can be placed under most conditions, including bearing capacity of bottom, current and tidal ranges, and it is possible to tow it in moderate seas. A well slot is provided for moving off a completed well and there are storage facilities for pipe, mud and drilling water.

The cost of this platform is about the same as that required to construct a permanent type platform, and the economy is obvious, as should the search for oil prove unsuccessful at one spot, the platform can be moved to another site for further borings to be undertaken.

The above description is of a specific mobile platform, designed and built for offshore oil exploration. Other platforms utilising the same design and power principles are to be manufactured by the R. G. LeTourneau, Inc., although specific uses for which they are intended may require different dimensions.

Cargo Handling in the Philippines—*continued*

often be handled very quickly six or more at a time, with suitable canhooks. All the men in the hold have to do is to roll the drums into the square of the hatch and engage a pair of hooks in the rims of each drum. On the quay, the hooks are disengaged and the drums rolled away. It would seem that the placing of drums on a wooden platform is often a slower method to employ. Moreover, an important time user is the manipulation of the platform itself.

However, this account of methods employed in the Philippines is of increased value and interest because views have been expressed as well as information given. An article in the December, 1955 issue of "The Dock and Harbour Authority" emphasised the need for attention at the time of loading to the requirements of discharging. Such knowledge as is contained in the article at present under review must assist Master Stevedores and others concerned with ship loading and discharging, to obtain a better overall picture of the work which is their livelihood.

St. Lawrence Seaway Dredging.

Further contracts for dredging the St. Lawrence Seaway channel were recently awarded to Marine Industries, Ltd., of Montreal, and Canadian Dredge and Dock Ltd., of Toronto. The work involves dredging for the entrance to Montreal Harbour and a turning-basin for ships entering or leaving the Seaway. The two contracts are valued at over 10 million Canadian dollars and the work is expected to be completed by August, 1958. About 3,200,000 cu. ft. of overburden and about 100,000 cu. yds. of solid rock are to be removed.

The total value of dredging contracts in connection with the Seaway is now $25 mn. and the total for all types of contracting work $72 mn.

Dock & Harbour Authorities' Association

Excerpts from Annual Report for 1955

The report for 1955 of the Executive Committee of the Dock and Harbour Authorities' Association, which was presented at the Annual General Meeting held in London on 22nd February last, refers to several matters of interest to readers of this Journal.

Oil in Navigable Waters Act, 1955

On this subject, the report states that the Association were particularly concerned with the provisions of Sect. 8 which deals with the facilities to be provided in harbours for the disposal of oil residues. As a result of representations made by the Association to the Ministry of Transport and Civil Aviation, the clause as originally introduced was amended so that the facilities, where they are to be provided by port authorities required for dry cargo ships other than ships undergoing repair, and then only to such facilities as are necessary to receive from such vessels ballast water which has been subjected to an effective process for separating the oil from the water.

Explosives in Harbours

During the year, the Association have been consulted on a new draft of Regulations for the Conveyance in Harbours of Government Explosives and Explosives of Visiting Forces, which is in similar terms to the existing regulations for the Conveyance of Government Explosives in Harbours.

No action was necessary by the Association on the terms of the new draft regulations as such, but the Association took the opportunity to ask the Minister of Supply to include in the new regulations a provision in the terms of the administrative instruction which has been issued by the Minister of Supply and the Service Departments to Government representatives, requiring them to see, so far as they are able, that directions given by the harbour master or any precautions required by him to be taken are complied with, that his attention is called to any breach of these directions or precautions that comes to their notice and that they do all in their power to correct the breach at once, where danger is imminent.

The Association still attach the utmost importance to the tightening up of the security arrangements relating to the handling of explosives, particularly having regard to the fact that if an explosion took place at one of the ports the consequences might well be disastrous.

Fire Fighting in Ships in Port

As the result of a meeting held at the Ministry of Transport and Civil Aviation in 1954, further consideration has been given by the interests concerned to the steps that should be taken to avoid fires in ports and to determine the best means of seeing that the recommendations of the Working Party on Fire Prevention and Fire Fighting in Ships in Port, made in 1949, are carried out.

Certain recommendations, made as the result of this meeting, were forwarded to members on 23rd September, 1954, and during the year further consideration has been given to the matter. Finally, on the 6th July, 1955, the Ministry of Transport and Civil Aviation issued a notice to shipowners, ship masters, ship builders and repairers which has also been circulated to members.

The whole question is of such importance to members and to port users that the opportunity is taken to draw attention to the following points from the latest notice.

(i) **Responsibility.** (Paragraph 30 of the Report of the Working Party.)

It has been reaffirmed that responsibility for fire prevention and fire fighting in ships under construction is the builder's responsibility and in ships under repair the owner's responsibility, unless, in either case, there is a written agreement to the contrary.

(ii) **Co-operation with Public Fire Brigades.** (Paragraph 16 of the Report of the Working Party.)

Steps should be taken to ensure that ship-to-shore communications provide the quickest possible contact with the public fire brigade at all times, and arrangements should be reviewed from time to time. In particular, all concerned should take steps to ensure that the facilities available to a particular ship are well known to those whose responsibility it would be to give the alarm in the event of fire. Liaison between ship builders and repairers, port authorties and local fire brigades should not, however, be confined to communications, but should also embrace training and fire-fighting arrangements generally.

(iii) **Smoking.** (Paragraph 21 of the Report.)

The need for care and caution in smoking in places where smoking is not prohibited should be the subject of extensive and continuous propaganda.

(iv) **Stability.** (Paragraphs 31 and 32 of the Report.)

When fire-fighting operations endanger a ship's stability and it is necessary to decide whether fire-fighting should cease, the decision of the Harbour Master or other responsible officer of the port authority, after consultation with all interested parties, should prevail. This does not, however, relieve the Master or, in his absence, the Officer-in-Charge, from bringing to the notice of the fire brigade officer any special circumstances affecting the safety of the ship, its stability, or the conduct of the fire-fighting operations.

In addition to reaffirming the Working Party's original recommendations, the Ministry of Transport and Civil Aviation have also made the following further suggestions:—

(v) **Daily List of Ships in Port.**

It is desirable that port authorities should provide each local fire brigade with either a daily list of ships in the brigade's area or such other information as will facilitate the operations of the brigade.

(vi) **Ejector Pumps connected to Fire Hoses.**

The use of ejector pumps as a means of freeing ships of water during fire-fighting operations may be of value.

It is hoped that members will do all in their power to see that the recommendations of the Working Party are compiled with and that the suggestions made in the Ministry's notice are carried out.

Undue Delays at Docks

During the year, considerable prominence has been given to statements that the development of the docks has not been adequate in the light of present-day requirements and that road transport has suffered undue delays within dock areas.

In the course of a detailed reply to these allegations the Association pointed out that in the case of the port of London over £14 million had been spent since 1946 on dock developments, and, in addition, a further £10 million had been expended on maintenance works. In all these schemes full regard had been given to the requirements of road transport. In Liverpool, the Mersey Docks and Harbour Board had a vast programme of post-war reconstruction amounting to over £15 million, and in addition to many major schemes already completed they have in hand capital works estimated to cost a further £15 million. Included in these works are many new sheds of the most modern design and embodying every provision for the efficient handling of traffic arriving or leaving by road or rail.

"Dock developments are in hand at other ports and the Association are satisfied that the ports are fully alive to the need for modernisation and development and, as the figures quoted indicate, very considerable progress has been made since the war to modernise port facilities. On the general question of port development, it must be remembered that, in addition to improving and modernising dock facilities to cater for increasing traffic and for ships of greater size, port authorities have also been called upon to undertake a vast programme for the repair and reinstatement of damage sustained during the war to buildings and plant of all descriptions.

"Comparison which is sometimes made with the Continental ports leaves out of account the fact that their installations were almost completely destroyed during the war and they were thus given the opportunity to replan and build anew without, moreover, the limitations imposed by encircling urban devolpment. There is the further fact that during the war years their trade had been

Dock and Harbour Authorities' Association—continued

largely destroyed and, by comparison with the ports of this country, was slow to build up to its pre-war level and in many instances is still below that level.

"In September, the Road Haulage Association convened a conference of all interested parties at national level, to consider the question of delays to road transport at the docks, and invited the Association to send a representative. In accepting the invitation the Association pointed out that the problems arising in connection with this question are such as to make them a more appropriate subject for local, rather than national, study, as there are wide differences of all kinds between one port and another and the material factors vary in each case. For these reasons, it seemed to the Association that there is a far greater likelihood of making progress if these problems are investigated locally in circumstances in which due regard would be paid to local conditions of all kinds.

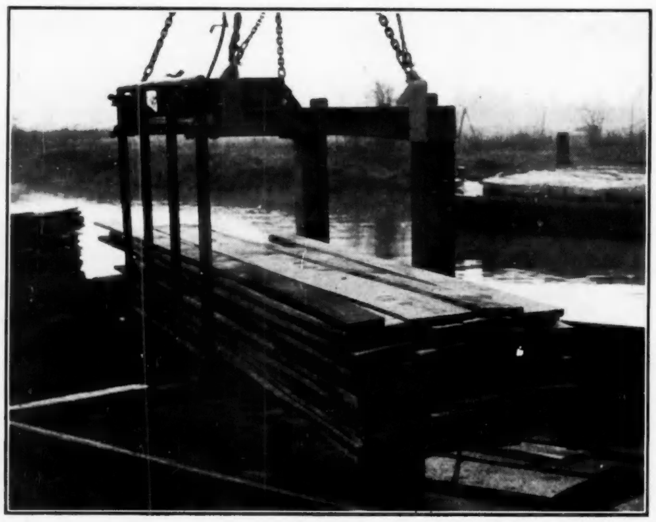
"The Conference agreed that the question of delays to road traffic was a local problem and decided to make an approach to the Ports Efficiency Committee and the Central Port Users' Committee. The Ports Efficiency Committee, have, as a result, asked the Port Operations Panel to produce figures, if that is possible, illustrating the speed at which road transport is dealt with after it arrives in a port area, and to say what steps are being taken to obviate delays.

"The Association appreciate that at times of severe pressure delays may occur, the causes of which may be many and varied, and they know that members will welcome the co-operation of all local interests concerned to help to overcome any difficulties that may arise. At the same time the Association believe it to be unfortunate that publicity is often given to exceptional cases and the inference drawn that they are normal."

Manufacturers' Announcements

A New Timber Handling Device

A new timber-handling device for use with a derrick or other crane has recently been supplied by George Cohen Sons and Co. Ltd., of London, N.W.10, the parent concern of the "600" Group of Companies. Intended for the unloading and stacking of hardwood in sticks and of sawn softwood delivered by barge, ship or lorry, it was developed on behalf of Messrs. Harris Lebus Limited, and is now in use at their works in Tottenham.



View of sling with gate in closed position.

The device consists basically of two "forks" similar to those employed in fork-lift trucks. To these has been fitted a pneumatically operated "gate" which, when in the raised position, allows the forks to slide under the load. The gate is then lowered until it engages in recesses in the tips of the forks, thereby securing the load and preventing it from sliding off the forks should they tip. Rotation of the "sling" is effectively prevented by a line attached to it and running on a spring-loaded drum mounted on the jib of the crane. The load capacity is 2 tons, the forks having a useful span of 3-ft. 6-in. and being spaced 5-ft. 6-in. apart.

In operation there are several advantages over the conventional type of wire-rope sling normally used for this kind of work. Unloading is considerably speeded up because, when handling sawn softwood, the sets do not collapse when the forks are withdrawn as they do when slings are used, and it is possible to stack them to a considerable height. There also is a complete avoidance of the damage often inflicted on the timber, by the constriction of a normal sling.

New Lighting System at Esbjerg Harbour

A specially planned lighting system has been installed at Esbjerg harbour, Denmark's third largest port. Consisting of sodium vapour lamps giving 68 lumens/watt, this new installation illuminates the quayside clearly and effectively penetrates misty atmospheres.

The fittings are of the enclosed type due to climatic conditions, and all auxiliary gear is housed within the body of the lantern.

For lighting the quays, 140-w. sodium lanterns are mounted on tubular masts with one or two top brackets at distances of between 45 and 65 yards. Fuses are fitted in boxes recessed into each mast

General view of floodlighting at Esbjerg Harbour.

so that every fitting has its own protective device. At points where the presence of masts would impede the passage of mobile cranes, supplementary lighting is supplied by airport floodlights housing 140-w. sodium lamps.

Primary roads in the harbour area are lit by 60-w. sodium lanterns mounted on tubular supports at distances of about 40 yards. In places the lanterns are mounted on walls.

To avoid excessive voltage drops on the cables, which are of comparatively small dimensions, the primary supply of electricity is distributed from six supply points, each serving a particular area of the harbour. All the supply areas are interconnected by control cables, and are controlled by a photocell installation. This installation also controls the electric navigation lights throughout the harbour. The fittings were manufactured by The General Electric Co. Ltd., London in conjunction with their agents, Louis Poulsen and Co., A/S, of Copenhagen.

Manufacturers' Announcements—continued

Self Propelled Hopper Barges

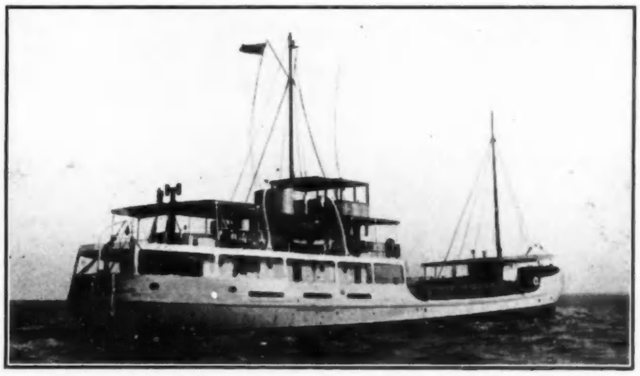
Brooke Marine Limited of Lowestoft, one of the Dowsett Group of Companies, have designed and constructed three self-propelled Hopper Barges for service with the Brisbane Harbour Authority, in Australia.

The principal particulars of these vessels are as follows: Length O.A. 170-ft. 8-in.; Length B.P. 160-ft.; Breadth Moulded 33-ft.; Depth Moulded 13-ft.; Load Draught 11-ft.; Deadweight (dredgings) 675 tons; Service speed 10 knots.

The vessels are of the flush deck type with raked bow and cruiser stern and are sub-divided by watertight bulkheads to form fore peak water ballast tank and chain locker, crew accommodation and hold, hopper, engine room and aft peak ballast tank.

An open type forged steel sternframe with semi-balanced rudder is fitted and a Donkin electric-hydraulic steering gear of the single cylinder piston type provides alternative hand and power steering from the bridge.

A combined electric and hand power windlass is fitted forward and an electric anchor and warping capstan with a horizontal cable is fitted aft, these units being of Thomas Reid manufacture.



M/V "Cowrie" sets out from Lowestoft for Australia.

The hopper having a carrying capacity of 675 tons of dredgings is emptied through ten doors, five port and five starboard, each hinging on the centre box keelson and recessed into the hull, so as not to project below the bottom plating when docking. The doors are operated by chain slings connected to mains chains which are led over cast iron sheaves and secured to a fabricated steel draw bar operated by hydraulic rams. A rigging screw is fitted in each leg of the slings so that adjustments can be made.

The hydraulic equipment is supplied by Donkin and Co., Ltd., and comprises two cast iron cylinders, one port and one starboard, designed for maximum working pressure of 1,800 lbs./sq. inch. Each cylinder opens and closes five hopper doors simultaneously; a lever operated double acting hydraulic hand pump is fitted into the system as an emergency in the event of the power pump breaking down. A separate control valve is provided on deck for each cylinder unit, making it possible to operate the units either singly or simultaneously. It is also possible to lower the doors on one side of the vessel whilst raising them on the opposite side, as this might be necessary if any of the doors become wedged with flotsam.

The main propelling machinery comprises a Crossley type CRL 5 cylinder vertical two stroke, single acting, direct reversing, scavenge pump marine diesel engine, developing 840 B.H.P.

Radar for River Navigation

After two years' research, the Decca Radar Company has evolved a river radar (Type 214) for inland waterway navigation. The principal experiments have been conducted on the Rhine, trial voyages between Basle and the North Sea ports of Amsterdam, Rotterdam and Antwerp being made by the motor vessel "Valcava," in conjunction with vessels of Schweizerische Reederei A.G., Basle.

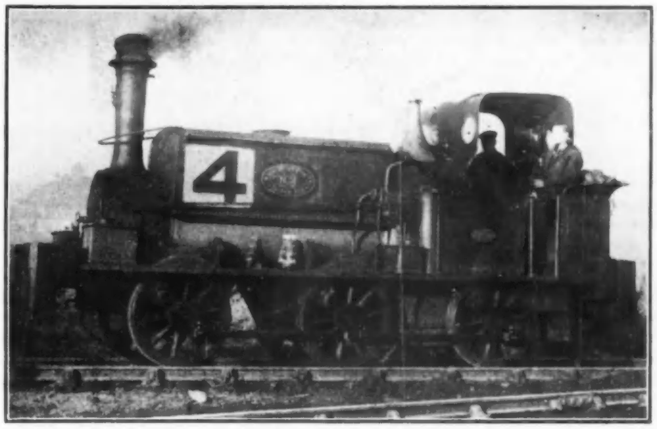
A pivot mast for low bridges carries the Radar scanner and gear box and, to assist in course-keeping when visual means of steering in a narrow channel are obscured, a rate-of-turn indicator has also been developed for use by the helmsman. The radar display unit is 9-in. in diameter, while the R.F. unit and power pack are compact and easily installed. Radar operation includes a high-definition display, off-centring to give a greater range in the forward direction (nearly seven miles normally) and a minimum range of between 10 and 15 yards with range discrimination of just over 10 yards.

On such stretches as the lower and middle Rhine (Rotterdam-Cologne and Cologne-Mannheim), self-propelled barges and tows can be assisted in adverse weather conditions, such as fog and bad visibility.

Decca Radar also announce that in the six years since they entered the field of marine radar their equipment has been fitted to over 5,000 ships of all classes throughout the world.

Veteran Shunting Locomotive

An unusual combination of equipment is to be seen at Dagenham Dock, which is operated by Samuel Williams and Sons, Limited. The dock shunting locomotive force consists of ten steam and four diesel locomotives. Among the steam locomotives is an engine, No. 4, which was built by Manning Wardle in 1877 and is still in daily use. In common with the remainder of the fleet, No. 4 is equipped with B.B.C. VHF radio telephone equipment, by means



of which the veteran can respond to fresh instructions as smartly as the post-war diesel locos. The VHF aerial projects from the top of the simple, one might almost say primitive, cab.

Samuel Williams and Sons Ltd. recently celebrated their centenary as dock operators, contractors and steamship operators. At present one of their docks is under reconstruction and it is hoped to publish a description of this work later in the year.

APPOINTMENTS VACANT

PORT OF BRISTOL AUTHORITY

Following vacancies exist in Engineer-in-Chief's Department, Avonmouth Docks.

Second Assistant Engineer (Electrical)

Salary Grade APT VI £880/£1,080 per annum.

Candidates should have served an approved apprenticeship and should be at least Graduate Members of Institution of Electrical Engineers. University degree and some experience of mechanical engineering added advantages.

Duties of section include installation, operation and maintenance of distribution and utilisation electrical equipment and preparation of specifications, estimates etc. for new work at Avonmouth, Bristol and Portishead. Electrical consumption is rising and has reached 16,000 Kva and 70 million units per annum.

Second Assistant Engineer (Mechanical)

Salary Grade APT VI £880/£1,080 per annum.

Candidates should have served an approved apprenticeship and should be at least Graduate Members of Institution of Mechanical Engineers. University degree and some experience of electrical engineering added advantages.

Duties of section include installation and maintenance of mechanical equipment (cranes, locomotives, etc.), and preparation of specifications, estimates etc. for new work.

Engineering Assistant (Civil)

Salary Grade APT 1 £530/£610 per annum.

Successful applicant will be engaged on general civil engineering work. Preference given to a prospective Associate Member of Institution of Civil Engineers.

Two Senior Draughtsmen and one Draughtsman

Salaries Grade APT V £795/£970 per annum and Grade APT IV £710/£885 per annum respectively.

Applicants for senior positions should have good knowledge of general civil engineering and building construction and be capable of preparing drawings for major schemes with minimum supervision. Similar experience required for Draughtsman position commensurate with salary offered.

Applicants who have specialised in building construction will be considered for one of the positions. There are prospects of promotion in due course.

Conditions Applicable to all Vacancies

Commencing salary within the ranges quoted will depend upon experience. Successful candidates required to pass medical examination before appointment and to serve probationary period of six months. Appointments are pensionable in accordance with provisions of the Local Government Superannuation Act 1953.

ENGINEERING ASSISTANT required for work at Southampton Docks at a starting salary of £770 per annum.

Applicants should have had experience in the design of dockside structures and buildings in steel and/or plain and reinforced concrete. While preference will be given to applicants who have passed or gained exemption from Final Parts I and II of the examination for Associate Membership of the Institution of Civil Engineers, consideration will also be given to those with extensive experience in one or other of the above branches of Civil Engineering.

Applications, stating age, qualifications, etc. should be addressed to the Docks Engineer, British Transport Commission, Herbert Walker Avenue, New Docks, Southampton.

BRITISH TRANSPORT WATERWAYS invite applications for the position of Divisional Engineer, North Western Division (office at Liverpool); salary range £1,900—£2,325 per annum, superannuation scheme and certain privilege railway travel facilities.

Applicants must be Corporate Members of the Institution of Civil Engineers with wide experience in design, construction and maintenance of inland waterway and marine works. The person appointed will be responsible for civil, mechanical and electrical matters of the Division; sound knowledge of general engineering practice required and ability to organise and assume efficient control of engineering staff.

Applications addressed to the Staff and Establishment Officer, British Transport Waterways, 22, Dorset Square, London, N.W.1, to arrive not later than 30th April, 1956.

MANAGER wanted to take complete charge of medium-sized marine engineering works, Clyde area, engaged in specialised contracts. Steam engine experience essential. Some diesel and electrical experience an advantage. Knowledge of lifting machinery design also advantageous. Post offers good remuneration and excellent prospects. Only men with some managerial experience and having first-class organising ability will be considered. Write stating age and giving full particulars of record and experience, to 0441, Wm. Porteous and Co., Glasgow.

CHIEF ENGINEER—Diesel Certificate—required for new vessel based Mauritius, 18/24 months. Reply giving full details to Box 185, "The Dock and Harbour Authority," 19 Harcourt Street, London, W.1.

PORT OF LONDON AUTHORITY
DRAWING OFFICE

The Port of London Authority have vacancies in their Drawing Office at Head Office, Trinity Square, E.C.3, in the following grades:

1. **Senior Technical Assistant**
   for reinforced concrete and steelwork design.

   Salary Scale:
   "A" £920 by varying increments to £1,075 per annum.
   "B" £700 by varying increments to £890 per annum.

   Qualifications required:
   For "A" Corporate membership of the Institution of Civil or Structural Engineers. Assistants joining in Section "B" of the grade will be considered for promotion to Section "A" when they have become corporate members of the Institution of Civil or Structural Engineers.
   For "B" Higher National Certificate or equivalent in appropriate subjects.

2. **Leading Technical Assistant**
   (i) for reinforced concrete and steelwork design and detailing under supervision.
   (ii) for design and detailing, under supervision, of dock mechanical equipment, high pressure oil pumping systems and handling plant.

   Salary Scale:
   £600 by £25 to £725 per annum.
   There is an increment bar at £650 per annum, progress beyond which will depend on service, ability and qualifications.

   Qualifications required:
   Ordinary National Certificate or equivalent in appropriate subjects. Assistants obtaining Higher National Certificate will be considered for promotion to Senior Technical Assistant.

3. **Technical Assistant**
   for land surveying and drawing under supervision.

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(ENGINEERING DEPARTMENT)
TENDER NOTICE

The Trustees of the Port of Karachi, Pakistan, invite tenders for the construction of FIVE REINFORCED CONCRETE TRANSIT SHEDS at Berths Nos. 6, 8, 11, 13 and 16 of the EAST WHARVES, KARACHI, in accordance with alternative designs consisting of (1) Shell Type Roof Design and (2) Flat Roof Design.

Tender documents comprising the Instructions for Tender, Form of Tender, General Conditions of Contract, Form of Bond, Specifications, Drawings and Bills of Quantities may be obtained from the office of the undersigned on payment of a non-refundable sum of Rs.250s, to the Chief Accountant (K.P.T.) on any working day during office hours, or from the Trustees' Consulting Engineers, Messrs. Rendel, Palmer and Tritton, 125 Victoria Street, London, S.W.1, United Kingdom on payment of a non-refundable sum of £20.

Tenders marked "Tenders for Transit Sheds" will be received by the undersigned up to Noon, Karachi local time, on 10th May 1956 and will then be opened in the presence of those Contractors who may wish to attend.

The Tenders are required to remain open for acceptance by the Trustees up to 31st August, 1956.

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